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A Classification of Forest Habitat Types of Northern New Mexico and Southern Colorado

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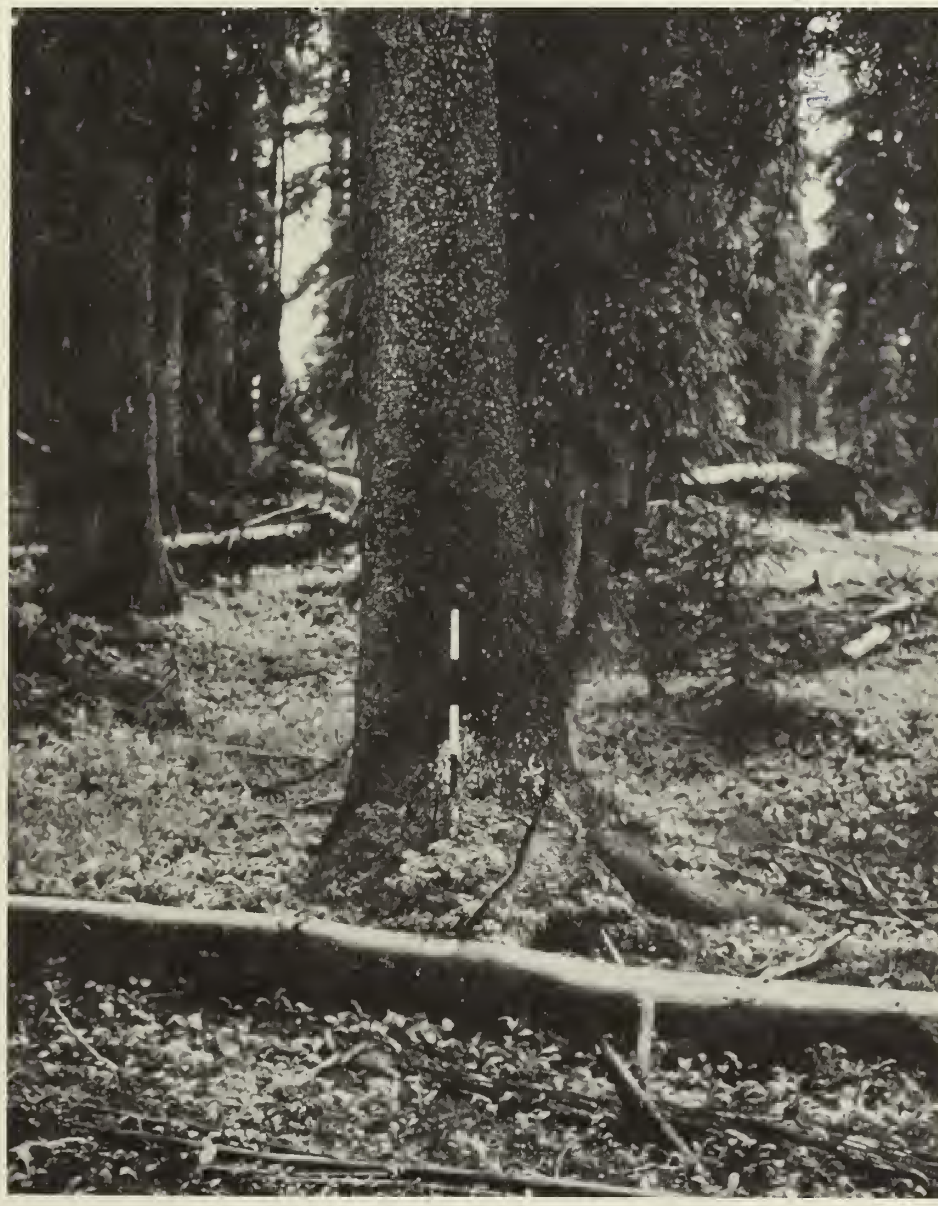

Abstract

Forest habitat types in the mountains of northern New Mexico and southern Colorado were identified and described to develop an ecosystem classfication. The final vegetation classification is based on 618 sample plots. A total of 8 climax series, 44 habitat types, and 12 phases of habitat types are defined. Keys and descriptions for each habitat type are provided. Soils and vegetation relationships, successional trends, management implications, tree productivity from site index, and relationships to other habitat type investigations in the Rocky Mountains are discussed.

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A Classification of Forest Habitat Types of Northern New Mexico and Southern Colorado[1]

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MANAGEMENT IMPLICATIONS

Habitat type systems, in conjunction with soils and topographic data, aid in delimiting logical units for management, and improve prediction accuracy for such characteristics as timber and forage production potentials (Layser 1974, Pfister 1976). Additionally, habitat type systems provide an ecological basis for categorizing environmental variation, provide a common system for improving communication among diverse investigators, and aid in improving sampling and experimental design (Pfister et al. 1977). Such usefulness provided the strongest rationale for selecting the habitat type approach for this forestland study in the southern Rocky Mountains.

Classifications of forestlands based on single-factor analyses, such as dominant vegetation, landforms, land uses, or soils, typically are either too general or lack the ecological basis needed for sound multiple-use management (Bailey et al. 1978, Corliss 1974). In contrast, climax vegetation serves as a key to the integrated environment, including climate, soil, and landform conditions as they affect vegetation composition (Daubenmire 1976). Efficient and successful land management is more probable when a classification system is available for dividing the landscape into units of contrasting biotic potentials (Driscoll 1964). The habitat type classification of forests has proven to be very useful to land managers, as evidenced by its general acceptance and utility in those regions where such classifications have been completed and polished (Pfister and Arno 1980).

Classification by habitat type does not imply that managers should manage for climax vegetation. For example, forage production for livestock declines rapidly with advancement of succession towards climax in many western forest habitat types (Pfister[5]); thus, maintenance of seral vegetation may be the goal of management. The usefulness of the climax concept, however, remains unchanged.

INTRODUCTION

Natural vegetation integrates all impinging environmental factors (Daubenmire 1976). Land areas capable of supporting a given plant association at climax are defined as the same habitat type (Daubenmire 1968). Recognition of forest habitat types has proven to be highly useful to land managers (Layser 1974, Pfister 1981). The main advantage of habitat types is that they provide a permanent and ecologically based system of delineating ecosystems (Pfister et al. 1977).

Habitat types are defined on sites with climax or near climax vegetation; thus, they assume stable or near stable climate, soils, and landform. Areas having seral vegetation can be mapped to habitat type by close examination of adjacent plant associations on the same site (Arno 1982), and by using prior studies of plant successional relationships (Pfister et al. 1977).

Forestlands are valuable public resources that provide timber, livestock, wildlife, watershed, and recreation. Effective management of forest resources requires a thorough understanding of how different habitat types respond to different management practices. A given habitat type represents a relatively narrow range of biotic potentials and, thus, a relatively narrow range of management options.

Forest plant association classifications have been developed for 30 areas in the western United States (Pfister 1981). Although this coverage is extensive, large areas still lack habitat type investigations. Prior to this study, little documentation of the forest vegetation of northern New Mexico and southern Colorado had taken place. Moir and Ludwig (1979) described mixed conifer and spruce-fir forests in northern New Mexico but did not sample the extensive ponderosa pine forests. Vegetation studies are generally lacking for the forests of southern Colorado, and those that have been done involved limited sampling areas. Peet (1981) sampled the Spanish Peaks; Dix and Richards (1976) sampled Missionary Ridge in the San Juan Mountains; Shepherd[6] sampled north of Alamosa, Colo.; and Langenheim (1962) sampled in the vicinity of Crested Butte, Colo. (slightly north of our study area).

The objective of this study was the identification and description of forest habitat types in the mountains of northern New Mexico and southern Colorado. The final classification is based primarily on vegetation. However, to produce a better ecological classification, soils and landform were also considered in the identification and description of habitat types.

STUDY AREA

PHYSIOGRAPHY

The study area encompasses the forests of northern New Mexico and southern Colorado. Specifically, they occur in the Spanish Peaks and Wet Mountains of Colo-

[5]*Pfister R.D. 1971. Management implications by habitat types. Habitat Type Training Session Manual, 30 p. USDA Forest Service Region 1, May 24-28. Coeur d'Alene, Idaho.*

[6]*Shepherd, Harold R. 1975. Vegetation of two dissimilar bighorn sheep ranges in Colorado. Division Report 4, 223 p. Colorado Division of Wildlife, Denver.*

rado, and the San Juan and Sangre de Cristo Mountains of both Colorado and New Mexico (fig. 1).

Most of the data were collected within National Forests; however, a relatively small number of study plots were established on private and public lands outside National Forest boundaries. The sampling area ranged in elevation from about 6,000 to 11,800 feet (1,830 to 3,600 m) and encompassed approximately 10 million acres (4 million ha).

Physiographic provinces in the United States are defined in Thornbury (1965). The three provinces represented in the study area may be described as follows.

Colorado Plateau Province

This province is bounded on the east by the San Juan Mountains uplift. Gently dipping sedimentary rocks characterize most of this province. Relief features are generally the result of incision of canyons into generally flat terrain, rather than upstanding mountain ranges. The Dakota Sandstone, Mesa Verde Sandstone, and Mancos Shale underlie much of the study area within the Colorado Plateau Province.

Forest series studied in the province are predominantly *Pinus ponderosa*. *Abies concolor* is rare in this province, and *Pseudotsuga menziesii* forests form a relatively minor topographic climax in some areas.

Southern Rocky Mountain Province

This province contains the major portion of the study area. Except for the San Juan Mountains in Colorado, the province is composed predominantly of north-south

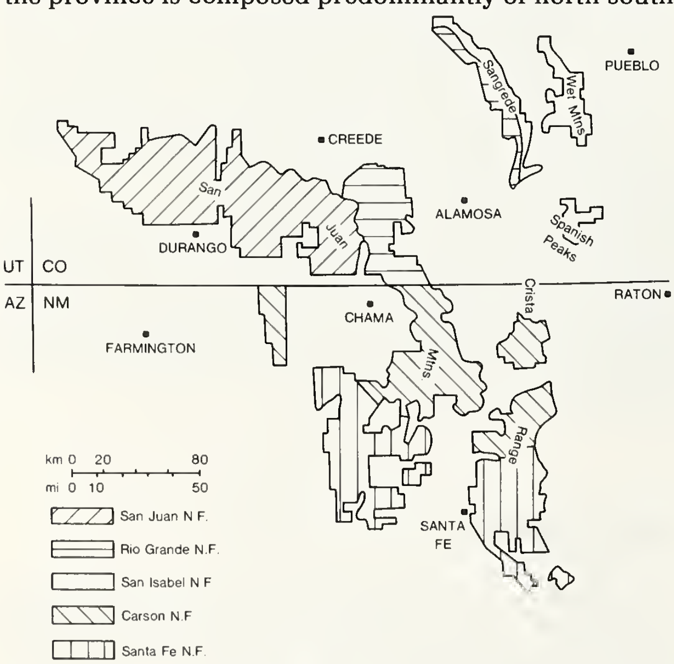

Figure 1.—Location of study area in northern New Mexico and southern Colorado, with National Forest administrative boundaries shown.

trending ranges of anticlinal structure having igneous and metamorphic rock cores flanked by sedimentary rocks. The ranges included in the portion of the Southern Rocky Mountain Province within the study area are the San Juan, Sangre de Cristo, and Wet Mountains. Secondary ranges are recognized within the extensive San Juan Mountains. These include the La Plata, San Miguel, Needle, and Rico Mountains in Colorado, and the San Pedro, Jemez, and Sierra de Nacimiento Mountains in New Mexico.

The San Juan Mountains were heavily glaciated during the Pleistocene. One late Wisconsin glacier, the Las Animas, was 40 miles (64 km) long, making it perhaps the longest in the Rockies during Pleistocene times. The western flank of the San Juan uplift is bounded by the La Plata, San Miguel, and Rico Mountains.

A dramatic example of volcanic activity is the Valles Caldera in the Jemez Mountains of New Mexico. The caldera measures about 15 miles (24 km) in diameter and was formed by collapse after extrusion of tremendous volumes of tuff.

The Sangre de Cristo Mountains extend from near Salida, Colo., to the vicinity of Santa Fe, N. Mex., a distance of about 140 miles (225 km). Both the Sangre de Cristo and Wet Mountains consist of a core of Precambrian schists, gneisses, pegmatites, and local bodies of granite and diorite, with complexly folded sedimentary rocks occurring in some locations. Extensive Pleistocene glaciation occurred in these mountains.

The Southern Rocky Mountains are the highest in the Rocky Mountain System. Many peaks in excess of 14,000 feet (4,270 m) elevation are found within the province. Because of the great environmental variation in the Southern Rocky Mountain Province, extensive examples of all forest series occur.

Great Plains Province

The Spanish Peaks of Colorado lie within this province. They represent two igneous plugs of granite and granodiorite porphyry. Prominent features of the Spanish Peaks are dikes radiating from the stocks, much like the spokes of a wheel; some of these dikes are 25 miles (40 km) long.

CLIMATE

Mountain climates of the western United States have been described by Baker (1944) and Bradley (1976). The average temperature lapse rate is 5.50° F per 1,000 feet (1.0° C per 100 m) elevation increase. Generally, precipitation increases with elevation in the mountains. Within the study area, an average of 40% of the annual precipitation falls during the period of June through August. The San Juan Mountains of Colorado are the wettest and coldest mountains in the study area largely because of greater snowfall and the absence of chinook winds.

Annual precipitation at 6,500 feet (1,980 m) elevation is approximately 16 inches (410 mm) throughout the

study area; however, annual precipitation at about 13,000 feet (3,960 m) ranges from approximately 40 inches (1,020 mm) in the San Juan Mountains in Colorado, to 35 inches (890 mm) in the mountains of northern New Mexico, and to 24 inches (610 mm) in the Sangre de Cristo Range, Wet Mountains, and Spanish Peaks of Colorado. The higher total precipitation at high elevations in northern New Mexico relative to the mountains east of the Continental Divide in southern Colorado probably relates to the rain shadow effect of the massive San Juan Mountains in Colorado. Local conditions may produce much higher precipitation. For example, subalpine rain forests in Colorado have been reported to receive in excess of 100 inches (2,540 mm) of precipitation during the summer (Ives 1942).

Maximum snowfall accumulations vary from 43 feet (13 m) in the San Juans of Colorado, to 26 feet (8 m) in the mountains of south-central Colorado, and to 16 feet (5 m) in the mountains of northern New Mexico.

The number of frost-free days varies from less than 50 days in the *Abies lasiocarpa* series to more than 120 days in the *Pinus ponderosa* series.

Daubenmire (1943) described vegetation zones in the Rocky Mountains and hypothesized the following causes of lower and upper altitudinal limits of species: (1) the upper limit is determined by temperature, (2) the lower limit is determined by low precipitation, and (3) at intermediate elevations exposure and soils are significant in controlling species distribution patterns.

Daubenmire (1943) further proposed that the upper timberline is primarily determined by desiccating winds. In southern Colorado, Bates (1924) observed that total wind for January averaged 13,000 miles (20,920 km) at upper timberline, but was less than 6,000 miles (9,660 km) in the *Picea engelmannii–Abies lasiocarpa* zone just below.

METHODS

FIELD PROCEDURES

Plots were carefully selected for sampling within stands of climax or near climax vegetation following the guidelines of Moir and Ludwig (1983). Forestlands that support, either currently or potentially, any of the following coniferous tree species or their combinations are considered climax or near climax: *Pinus aristata, Picea engelmannii, Abies lasiocarpa, Picea pungens, Abies concolor, Pinus flexilis, Pseudotsuga menziesii*, and *Pinus ponderosa*.

There is considerable disagreement among ecologists regarding the climax or seral status of *Pinus contorta* and *Populus tremuloides* in the Rocky Mountains (Hoffman and Alexander 1980). Supporting the possibility of these species being climax, Moir (1969) recognized a *P. contorta* zone in the Colorado Front Range where *Pseudotsuga menziesii, Abies lasiocarpa*, or *Picea engelmannii* had not invaded in 65 to 100 years of pine dominance. Despain (1983) noted climax *P. contorta* communities in Wyoming. Similarly, *P. tremuloides* was observed forming 150-year-old stands in northern Colorado where succession towards *Abies and Picea* was not evident (Hoffman and Alexander 1980). Generally, replacement of *P. tremuloides* requires about 65 years (Ives 1941). *P. contorta* occurs as a minor component of forests in the Sangre de Cristo Range, Spanish Peaks, and Wet Mountains of Colorado. Stands dominated by either of these species were outside the scope of this study.

To minimize the confounding nature of successional vegetation on disturbed sites, areas severely overgrazed, recently logged, herbicide treated, mechanically disturbed, artificially seeded, or irrigated were not sampled. Plots were established within portions of stands that appeared to be relatively uniform in topography and vegetation structure. Efforts were made to locate plots to accurately represent tree and undergrowth vascular plant composition, stocking, and visible site factors of the stand.

The procedures for sampling followed those described by Moir and Ludwig (1983). Both reconnaissance plots and analytical plots were included in the study (Daubenmire and Daubenmire 1968, Franklin et al. 1970, Pfister and Arno 1980, Moir and Ludwig 1983). Analytical plots were used to check and calibrate accuracy of shrub and herb coverage as estimated by the reconnaissance plot method (Pfister and Arno 1980), which is more rapid than the analytical plot method by a factor of two to three. In contrast to coverage measurements taken for shrubs and herbs, tree densities were estimated by numbers of individuals per 2-inch (5-cm) diameter class, providing a better indication of relative reproductive rates among the tree species than coverage (Moir and Ludwig 1983).

A total of 618 plots (375 m^2 per plot) were sampled and each was documented by 35-mm color and/or black and white photographs. In addition, soil profiles observed in soil pits dug in the center of the plots were described for 443 plots. The soils were classified to the subgroup level of soil taxonomy (Soil Survey Staff 1975). Ideally, soil descriptions should be complete enough to classify to family level. Caution is necessary in making generalizations concerning this soils information for four reasons. First, time constraints limited most pit depths to 20 inches (50 cm), instead of the 60 inches (150 cm) generally used when describing southwestern forest soils (Gass et al. 1981). Second, only thickness, structure, texture, color, and coarse fragment content of each horizon were recorded for each pedon. Third, descriptions are based solely on field observations; no samples were collected for laboratory verification of field descriptions. Fourth, our sample of plant associations does not necessarily cover the most widespread soil types. For example, Inceptisols may be overrepresented because they occur on the steep, relatively undisturbed terrain on which many of the plot samples were located. Alfisols typically occur on gently sloping sites that are more disturbed by logging and grazing; thus, they were sampled less in this study.

DATA ANALYSIS

At the end of each field season (summers of 1973, 1980, 1981, and 1982),[7] plant voucher collections were identified and field data refined. Complete plot location data and soil-site data were computer coded in a standard format. These floristic and site data were analyzed using the successive approximation classification strategy outlined by Pfister and Arno (1980) and Moir and Ludwig (1983). Basically, ordination (Pielou 1977) and releve table manipulations (Shimwell 1971) were used to develop a preliminary habitat type classification. Evaluation of the objective results obtained by quantitative analyses was tempered by subjective ecological judgment (Williams 1967).

Site index (100 year base age) of each plot was estimated based on one to three trees of *Picea engelmannii*, *Pseudotsuga menziesii*, or *Pinus ponderosa*, the species depending on the forest series. *P. engelmannii* site index estimates were based on curves developed by Alexander (1967), while *P. menziesii* and *P. ponderosa* site index estimation followed Edminster and Jump (1976) and Minor (1964), respectively.

Timber productivity was rated low, moderate, or high, where low site index = 54 and less, moderate = 55–74, and high = 75 and above. Also, slope steepness was categorized for each habitat type as follows: gentle = 0–10%, moderate = 11–45%, steep = 46–80%, and very steep = in excess of 81%.

Keys and descriptions for each habitat type were written, resulting in this vegetation classification system for the forests of northern New Mexico and southern Colorado.

Soils and vegetation relationships, successional trends, management implications, tree productivity (based on site index), and relationships to other habitat type classifications in the Rocky Mountains were also described for the habitat types. Such descriptions must be considered preliminary since they are based only on data taken in developing this classification. Caution is necessary in relating habitat types described here to those in other areas; composition of entire stands must be considered because the species complement varies geographically (Pfister 1972).

TAXONOMIC CONSIDERATIONS

Nomenclature follows Weber and Johnston (1979). Scientific names of all species in this study and their synonyms are listed in appendix 1.

Certain species were difficult to distinguish in the field, particularly the separation between *Vaccinium scoparium* and *V. myrtillus* because the mature fruits needed to definitively separate these species were rarely available. *V. scoparium* gains dominance over *V. myrtillus* in colder and drier environments (Peet 1981), but the ranges of the two species overlap for the most part. Since *V. scoparium* and *V. myrtillus* are closely similar ecologically (Pfister et al. 1977), all specimens keying to either *V. scoparium* or *V. myrtillus* in this study were grouped under *V. myrtillus*, the more common of the two species. Similarly, the necessary fruits were rarely available for the distinction of *Thermopsis divaricarpa* (*T. pinetorum*) from *T. montana* and *Lathyrus leucantus* from *L. arizonicus*. Thus, these species were grouped under the general headings of *Thermopsis* spp. and *Lathyrus* spp. *Pinus flexilis*, *P. strobiformis*, and their hybrids occur in the study area. Pure *P. flexilis* is characteristic of exposed situations at high elevations, while pure *P. strobiformis* occurs primarily at mid elevations (Layser and Schubert 1979). Because a continuum of variation occurs between these two species, all specimens of this complex were classed as *P. flexilis*.

In northern New Mexico, *Quercus grisea* occurs in addition to *Q. gambelii*. Hybrids between these species have been referred to as *Q. undulata* (Tucker 1961). In this study, those oaks with the most coriaceous subentire leaves are referred to as *Q. undulata*.

Carices were identified using Hermann's (1970) manual. Carices in the section Montanae were generally identified as *Carex rossii* if caespitose or as *C. heliophila* if rhizomatous. Additionally, Harrington (1954) and Weber (1976) were invaluable references for field and herbarium identification of many plants.

DEFINITIONS

Use of climax plant associations—combination of climax tree and undergrowth dominants—as indicators of similar biological potential is termed "habitat typing." "Cover type" and "habitat type" (HT) are not synonyms; cover typing tells something about the current cover but does not consider successional status (Layser and Schubert 1979). In contrast, habitat typing stresses potential climax and, thus, may or may not indicate current cover, but it does communicate something about secondary succession, potential cover, and the environmental conditions (Layser and Schubert 1979).

Associations allow the recognition of more ecologically distinct areas than would be possible if only understory or overstory were considered alone (Daubenmire and Daubenmire 1968), because overstory and undergrowth generally occupy the land independently. The same tree canopy can occur over almost wholly different ground covers. In general terms, one might hypothesize that the tree stratum is more closely tied to macroclimate, whereas the undergrowth is more sensitive to microclimate (Daubenmire and Daubenmire 1968).

Plots were grouped according to the tree species showing the strongest evidence of self-perpetuation—the climax tree species. This is termed the series level of the classification (Hoffman and Alexander 1976). Each series was then subdivided based on the dominant or characteristic undergrowth species, or pair of species in some cases, in the climax community. Thus, habitat type names are two-part. For example, in the habitat type name *Pinus ponderosa/Festuca arizonica*, the first part of the name is the climax tree species and the second part is the climax undergrowth indicator species (Pfister

[7]Field data collected by Moir in the summer of 1973 in higher elevation forests (Moir and Ludwig 1979) were combined with the 1980, 1981, and 1982 data for all subsequent analyses.

and Arno 1980). In instances where a pair of undergrowth species were used, the two species were separated by a hyphen when of the same life form, or by a slash when of different life forms (e.g., *Abies lasiocarpa/Vaccinium myrtillus-Rubus parviflorus* and *Picea engelmannii/Vaccinium myrtillus/Polemonium pulcherrimum* habitat types, respectively). Further, heterogeneous types were divided into phases, which represent incipient habitat types not at present considered distinct enough for recognition at the habitat type level. Habitat type names were chosen for brevity and for appropriateness in conveying a sense of environmental conditions over a given range. The name does not infer that the only species in the stand are those given in the name. Codominance of two or more tree species at climax and the occurrence of 30 or more understory species is not uncommon.

Use of climax plant associations to name habitat types does not imply an abundance of climax vegetation in the present landscape (Pfister et al. 1977, Steele et al. 1981). Most current vegetation reflects some form of disturbance and various stages of succession towards climax. Indeed, in areas where timber harvesting and overgrazing have been pervasive, climax vegetation structure is essentially absent. However, habitat types can usually be identified even in seral stands by noting the relative reproductive success of the species present in comparison with known successional trends (Pfister et al. 1977). Stands representing very early successional stages can often be identified to habitat type by comparison with adjacent mature stands having similar topographic and edaphic features (Arno 1982, Pfister et al. 1977).

Plant communities and the soils supporting them are both functional products of the interaction of organisms, climate, geomorphology, parent material, and time (Jenny 1941, Major 1951). Therefore, it should be expected that direct relationships exist between the two complexes (Driscoll 1964). Although correlations between vegetation and soil do not always occur (Daubenmire 1970), they have been reported by many investigators (Anderson 1956, Despain 1973, Driscoll 1964, Spilsbury and Tisdale 1944, Tisdale 1947, Wentworth 1981). Correlations between climates at a "zonal" level, vegetation at a Subseries taxonomic level, and soils at the Subgroup taxonomic level, with modifiers, are major elements of the Terrestrial Ecosystem Survey procedure of the USDA Forest Service, Southwestern Region (Gass 1983).

In a Montana study, Munn et al. (1978) found that range habitat types and soil taxonomic units were related along moisture and soil development gradients. Further, Carleton et al. (1974) found strong relationships between soil moisture and temperature regimes (Soil Survey Staff 1975) and potential natural vegetation in northern New Mexico.

RESULTS AND DISCUSSION

The forest vegetation classification developed for northern New Mexico and southern Colorado defines 44 habitat types and 12 phases in 8 climax forest series (table 1). Keys, and instructions for their use, to identify habitat types are presented in appendix 2.

Nearly all of the classification relates to nonriparian forests with well-developed soil profiles, although some habitat types are described for scree and riparian forests as well. Series descriptions generally follow those of Layser and Schubert (1979) for the Southwest, but are refined for specific application to the northern New Mexico-southern Colorado study area. Generally, habitat types are described in order from cool and moist to warm and dry.

In identifying habitat types in the field, full use should be made of written descriptions in the text and the following material given in the appendixes: plant list (appendix 1), successional status table (appendix 3), tree density and undergrowth cover and constancy tables (appendix 4), and habitat type mozaic diagram (appendix 5). Ideally, identification is best achieved by examining near-pristine vegetation, because the classification was developed from mature, minimally disturbed forest. In practice, however, the classification can be applied to existing forests, and habitat types often can be determined from earlier successional stages. Adjacent habitat types can also aid in identification; however, only the major adjacent habitat types are discussed in this paper.

HABITAT TYPE DESCRIPTIONS

Pinus aristata Series

Pinus aristata/Festuca thurberi habitat type (PIAR/FETH; bristlecone pine/Thurber fescue)

The *Pinus aristata* series is of minor extent in the study area and is represented by only two habitat types: PIAR/FETH and PIAR/FEAR. The PIAR/FETH HT occurs predominately at upper timberline in the San Juan Mountains and Sangre de Cristo Range of Colorado.

Vegetation.—*Picea engelmannii* and *Pinus aristata* typically codominate the overstory. However, in some stands only one of these species may be dominant, the other minor or absent. *Festuca thurberi* is the most conspicuous undergrowth component. Other undergrowth species often present include: shrubs—*Ribes montigenum*; forbs—*Achillea millefolium* ssp. *lanulosa*, *Arnica cordifolia*, *Chamerion angustifolia*, *Oreochrysum parryi*, *Polemonium pulcherrimum* ssp. *delicatum*, *Saxifraga bronchialis*, *Thalictrum fendleri*, and *Trifolium dasyphyllum*.

Physical setting.—This habitat type is generally found on mid and upper slopes at elevations exceeding 10,500 feet (3,200 m), primarily at upper timberline (fig. 2) but sometimes elsewhere in the *Picea engelmannii-Abies lasiocarpa* zone where tree growth is limited by drought. Soils vary from Cryorthents to Cryoborolls. The soils are characteristically skeletal, particularly in those situations where *Pinus aristata* is dominant.

Adjacent habitat types.—The PIAR/FETH HT adjoins *Festuca thurberi* grasslands in drier situations and the PIEN/VAMY/POPU HT on moister sites, such as northerly or less windy exposures.

Table 1.—List of northern New Mexico-southern Colorado forest habitat types and phases by series.

Series Habitat type name	Abbreviation	Number of plots
Pinus aristata series		
Pinus aristata/Festuca thurberi	PIAR/FETH HT	7
Pinus aristata/Festuca arizonica	PIAR/FEAR HT	4
Picea engelmannii series		
Picea engelmannii/Vaccinium myrtillus/Polemonium pulcherrimum	PIEN/VAMY/POPU HT	
Picea engelmannii phase	PIEN phase	15
Abies lasiocarpa phase	ABLA phase	38
Abies lasiocarpa series		
Abies lasiocarpa/Mertensia ciliata	ABLA/MECI HT	14
Abies lasiocarpa/Moss	ABLA/Moss HT	14
Abies lasiocarpa/Vaccinium myrtillus	ABLA/VAMY HT	62
Abies lasiocarpa/Vaccinium myrtillus-Linneae borealis	ABLA/VAMY-LIBO HT	21
Abies lasiocarpa/Vaccinium myrtillus-Rubus parviflorus	ABLA/VAMY-RUPA HT	7
Abies lasiocarpa/Rubus parviflorus	ABLA/RUPA HT	11
Abies lasiocarpa/Erigeron eximius	ABLA/EREX HT	40
Picea pungens series		
Picea pungens/Linnaea borealis	PIPU/LIBO HT	8
Picea pungens/Erigeron eximius	PIPU/EREX HT	13
Picea pungens/Carex foenea	PIPU/CAFO HT	5
Picea pungens/Arctostaphylos uva-ursi	PIPU/ARUV HT	4
Picea pungens/Festuca arizonica	PIPU/FEAR HT	9
Abies concolor series		
Abies concolor/Vaccinium myrtillus	ABCO/VAMY HT	13
Abies concolor/Erigeron eximius	ABCO/EREX HT	18
Abies concolor/Acer glabrum	ABCO/ACGL HT	22
Abies concolor/phase	ABCO/Sparse HT	26
Abies concolor/Arctostaphylos uva-ursi	ABCO/ARUV HT	7
Abies concolor/Festuca arizonica	ABCO/FEAR HT	10
Abies concolor/Quercus gambelii	ABCO/QUGA HT	13
Pinus flexilis series		
Pinus flexilis/Arctostaphylos uva-ursi	PIFL/ARUV HT	4
Pseudotsuga menziesii series		
Pseudotsuga menziesii/Festuca arizonica	PSME/FEAR HT	7
Pseudotsuga menziesii/Quercus gambelii	PSME/QUGA HT	
Festuca arizonica phase	FEAR phase	12
Quercus gamelii phase	QUGA phase	11
Pinus ponderosa series		
Pinus ponderosa/Arctostaphylos uva-ursi	PIPO/ARUV HT	10
Pinus ponderosa/Festuca arizonica	PIPO/FEAR HT	
Danthonia parryi phase	DAPA phase	7
Festuca arizonica phase	FEAR phase	18
Bouteloua gracilis phase	BOGR phase	8
Pinus ponderosa/Quercus gambelii	PIPO/QUGA HT	
Festuca arizonica phase	FEAR phase	21
Quercus gambelii phase	QUGA phase	26
Pinus edulis phase	PIED phase	14
Pinus ponderosa/Muhlenbergia montana	PIPO/MUMO HT	9
Pinus ponderosa/Bouteloua gracilis	PIPO/BOGR HT	
Schizachyrium scoparium phase	SCSC phase	14
Bouteloua gracilis phase	BOGR phase	18
Pinus ponderosa/Quercus undulata	PIPO/QUUN HT	9
Pinus ponderosa/Artemisia arbuscula	PIPO/ARAR HT	6
Pinus ponderosa/Oryzopsis hymenoides	PIPO/ORHY HT	1
OTHER HABITAT TYPES		
Scree forests		
Pinus aristata/Ribes montigenum	PIAR/RIMO HT	1
Picea engelmannii/Saxifraga bronchialis	PIEN/SABR HT	8
Abies lasiocarpa/Saxifraga bronchialis	ABLA/SABR HT	1
Abies concolor/Holodiscus dumosus	ABCO/HODU HT	4
Pseudotsuga menziesii/Holodiscus dumosus	PSME/HODU HT	4
Pinus ponderosa/Ribes inerme	PIPO/RIIN HT	1
Riparian forests		
Picea engelmannii/Heracleum spondylium	PIEN/HESP HT	3
Picea pungens/Swida sericea	PIPU/SWSE HT	7
Picea pungens/Poa pratensis	PIPU/POPR HT	6
Abies concolor/Galium triflorum	ABCO/GATR HT	4
Pinus ponderosa/Poa pratensis	PIPO/POPR HT	3

Comments.—Stands of this habitat type generally have a parklike appearance, with widely spaced trees or occasionally clusters interspersed with *Festuca* meadows. Because of strong representation of the highly palatable *Festuca thurberi*, the grazing potential of this habitat type is high. However, the generally remote locations of this type make access difficult. This, combined with typically steep slopes, generally in excess of 50%, limits utilization of this habitat type for domestic grazing. Esthetic attributes are probably of greater economic value than the more typically resource-oriented uses that are often a prime consideration in management. Wildlife use, especially as summer range for elk, is an important characteristic of this type. Timber productivity for *Picea engelmannii* is low.

Fires are important within the habitat type but seldom attain high enough intensity in the grass-dominated undergrowth of these open forests to result in devastating crown fires.

Pinus aristata is dominant or codominant in generally drier and more exposed situations. In some locations, *Festuca arizonica*—a typically drier site, lower elevation species than *F. thurberi*—occurs in association with *F. thurberi*.

Unlike situations within other habitat types—PIEN/VAMY/POPU, ABLA/VAMY, or ABLA/Moss—where *Pinus aristata* forms a minor seral component (Moir and Ludwig 1979), the more open forest situations in this type fail to give the more highly shade tolerant *Picea engelmannii* a competitive edge over *Pinus aristata*. Codominance of the two species, or, in some instances, sole occurrence of *P. aristata* is expressed in the PIAR/FETH HT. *Abies lasiocarpa* is a minor component in this rather dry habitat type, supporting Peet's (1981) suggestion that *Picea engelmannii* is more drought-tolerant than *A. lasiocarpa*.

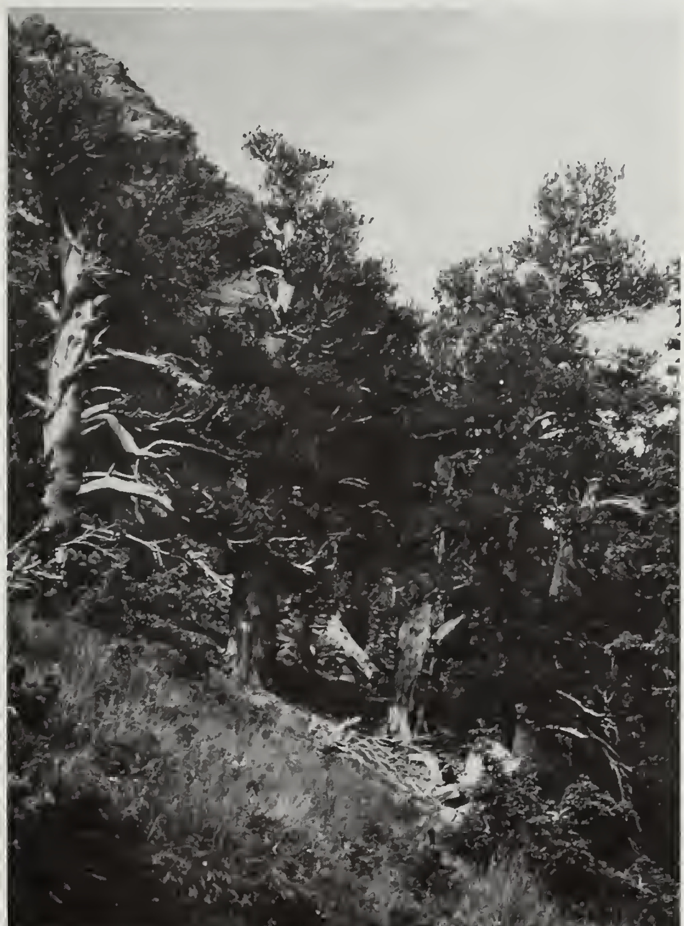

Figure 2.—***Pinus aristata/Festuca thurberi* habitat type, Sangre de Cristo Mountains at 11,500 feet (3,500 m).**

Dix and Richards (1976) presented data from a plot on Missionary Ridge in the San Juan Mountains of Colorado that fit the description of the PIAR/FETH HT, although *Pinus aristata* is absent from their plot. Additionally, Shepherd[6] identified a *Picea engelmannii-Festuca ovina-Potentilla fruticosa-Achillea lanulosa* habitat type in the Mosquito Range of central Colorado, and Pfister et al. (1977) described a *Pinus albicaulis* habitat type in Montana, both of which share environmental affinities with this type.

Pinus aristata/Festuca arizonica habitat type (PIAR/FEAR; bristlecone pine/Arizona fescue)

This minor habitat type occurs primarily in the Sangre de Cristo Mountains of New Mexico.

Vegetation.—*Pinus aristata* (fig. 3) dominates or is codominant with *Pseudotsuga menziesii* in the overstory. Grasses dominate the undergrowth, characteristically, *Festuca arizonica*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Poa fendleriana*.

Physical setting.—The PIAR/FEAR HT occurs primarily on steep southerly to westerly upper slopes. Elevations range from 8,600 to 10,000 feet (2,620 to 3,050 m). Soil surfaces typically exhibit rock covers in excess of 15%.

Adjacent habitat types.—Adjoining habitat types include the PIAR/FETH HT at higher elevations and the PSME/FEAR HT at lower elevations.

Comments.—The PIAR/FEAR HT is synonymous with the *Pinus aristata, Festuca arizonica, Muhlenbergia montana, Ribes cerneum* habitat type of Shepherd.[6] To maintain consistency with the two-part nomenclature used throughout this report, the name *Pinus aristata/Festuca arizonica* is used instead of the four-part name of Shepherd.[6]

Picea engelmannii Series

Picea engelmannii/Vaccinium myrtillus/Polemonium pulcherrimum habitat type (PIEN/VAMY/POPU; Engelmann spruce/myrtle blueberry/Jacobs ladder)

The PIEN/VAMY/POPU HT is the only one in the *Picea engelmannii* series. The type is widespread at the highest elevations of northern New Mexico and southern Colorado. It occurs in all mountain ranges exceeding 10,500 feet (3,200 m).

Vegetation.—At the highest elevations, *Picea engelmannii* dominates the overstory, while at slightly lower

elevations within the type, both *P. engelmannii* and *Abies lasiocarpa* can be found, the latter often less commonly as mature trees. *Pinus aristata* is sometimes present as a seral tree near the forest-tundra ecotone. The type is above the elevational limits of *Populus tremuloides*.

The undergrowth is characterized by *Vaccinium* spp., ranging in cover from 5% to 95%, and such cold indicator species as *Ligularia amplectens, Luzula parviflora*, and *Polemonium pulcherrimum* ssp. *delicatum* (fig. 4). The presence of *Erigeron eximius* indicates warmer situations within the habitat type.

Two phases are recognized: (1) *Picea engelmannii* (PIEN) phase, in which *P. engelmannii* is climax; and (2) *Abies lasiocarpa* (ABLA) phase, with *A. lasiocarpa* climax or co-climax.

Physical setting.—This habitat type occurs at upper timberline, often in cirques and other cold sites that retain snow cover late into the summer. Elevations range from 9,800 to 11,800 feet (2,990 to 3,600 m), with plots in the PIEN phase generally on sites higher than 11,200 feet (3,410 m) and the ABLA phase generally lower than 11,500 feet (3,500 m). The type occurs on all aspects and on moderate to steep slopes. Soil great groups represented in decreasing order of extent are Cryoboralfs, Cryoborolls, and Cryochrepts.

Figure 3.—*Pinus aristata/Festuca arizonica* habitat type, Sangre de Cristo Mountains. The scale-reference rod is banded in five 7.9 inch (2-dm) segments.

Figure 4.—*Picea engelmannii/Vaccinium myrtillus/Polemonium pulcherrimum* habitat type, *Abies lasiocarpa* phase, San Juan Mountains.

Adjacent habitat types.—While the upper limit of the PIEN/VAMY/POPU HT typically borders alpine tundra, in some instances it adjoins the PIAR/FETH HT. Stands of this type form alternate fingers with those of the very wet ABLA/MECI HT in the San Juan Mountains of Colorado where seeps are common at high elevations. The type often adjoins the ABLA/Moss HT on drier exposures. In almost all locations, the type is bounded at lower elevations by the ABLA/VAMY HT.

Comments.—The habitat type is generally restricted to the coldest extremes of forest growth. Tundra species commonly present include *Acomastylis rossii, Bistorta vivipara, Deschampsia caespitosa, Sibbaldia procumbens*, and *Trifolium dasyphyllum*.

Snowfall and snow accumulation surpass that of all other habitat types in the study area. Dix and Richards (1976) note that *Vaccinium* spp. and *Polemonium pulcherrimum* both increase in frequency with increase in snowpack duration.

If timber is harvested, shading of *Picea engelmannii* regeneration is necessary to prevent insolation damage (Ronco 1970). Under some stand conditions, partial cuttings are likely to result in losses from blowdown (Alexander 1973). The rigorous subalpine environment of this type severely limits timber productivity. Since snow accumulations are typically significant, watershed attributes may be an important consideration for managers. Additionally, esthetic values for recreational pursuits are high.

Moir and Ludwig (1979) first identified the PIEN/VAMY/POPU HT as the *Picea engelmannii/Vaccinium scoparium/Polemonium delicatum* habitat type. The name change reflects the identification problems previously discussed in the case of *Vaccinium*, and the revised taxonomy of Weber and Johnston (1979) in the case of *Polemonium*. Similar types have been reported from the central Rocky Mountains. Peet (1981) described xeric and subalpine *Picea-Abies* forest communities near the tundra-forest ecotone in Rocky Mountain National Park, Colorado. Shepherd[6] reported a *Picea engelmannii-Ribes montigenum-Polemonium delicatum-Bromus* spp. habitat

type in the Mosquito Range of central Colorado. High-elevation plots in the *Abies lasiocarpa/Vaccinium scoparium* habitat type in Utah (Pfister 1972) exhibit high contancy of *Polemonium*. Additionally, affinities occur with the *Picea engelmannii-Abies lasiocarpa/Salix glauca* habitat type described in central Colorado (Hess and Wasser[8]). The *Sibbaldia-Bistorta* phase of the *Abies lasiocarpa/Vaccinium scoparium* habitat type in southeastern Wyoming (Wirsing and Alexander 1975) is also similar to the *Polemonium* type described here. In the northern Rocky Mountains, the *Abies lasiocarpa/Luzula hitchcockii* habitat type represents similar environments to those described here (Pfister et al. 1977, Steele et al. 1981).

Abies lasiocarpa Series

This series occurs throughout the highest elevations of the study area, and high similarity exists among habitat types within this series throughout the Rocky Mountains. Forests in this series are extensive and are of considerable economic importance.

Vegetation.—Most overstories exhibit codominance of *Abies lasiocarpa* and *Picea engelmannii*. However, young *Abies* typically outnumber the less shade tolerant *Picea*, suggesting a tendency towards climax dominance by *Abies* (Pfister 1972). *Abies* has a furthur reproductive advantage in that both layering and reproduction by seed can occur, while *Picea* reproduces primarily by seed (Hoffman and Alexander 1976). *Picea* is the more long-lived of the two species, however, so few pure *Abies* stands occur.

Following major disturbance, *Populus tremuloides* is a major seral species at the lower elevations of the series. In rare instances, *Pinus contorta* replaces *Populus tremuloides* as the seral component. Lower elevations in this series also support *Abies concolor* and *Pseudotsuga menziesii* as seral or minor climax components. Sites at upper elevations undergo direct successions to *Picea engelmannii* and *Abies lasiocarpa*.

Undergrowths are highly varied. Maximal mesic conditions are reached within this series, in the ABLA/MECI HT. Within the wet forests, species lists commonly exceed 50 taxa in a given plot. Very cold conditions also are prevalant within this series, particularly in the ABLA/VAMY HT.

Vaccinium spp. are the most characteristic undergrowth plants of most communities in the *Abies lasiocarpa* series. Havas (1971) suggests the distribution of *Vaccinium* spp. is affected by the accumulation and persistence of snow, which prevents dessication. The occurrence of *Vaccinium* spp. thus suggests cold, snowy environments characteristic of the *A. lasiocarpa* series.

Physical setting.—At the highest elevations in the series (11,800 feet or 3,600 m), environments include cirques and other cold sites that retain snow cover late into summer, while lower elevations (8,850 feet or 2,700 m) are relatively warm. All landform types occur within the series, ranging from dry-exposed ridges (ABLA/Moss HT) to wet-sheltered seep slopes (ABLA/MECI HT). Soils are all in cryic great groups (Carleton et al. 1974).

Adjacent habitat types.—At its upper limit, the *Abies lasiocarpa* series borders either the *Picea engelmannii* series or alpine tundra. At its lower limit, the series adjoins the *Picea pungens* series and herb-rich habitat types in the *Abies concolor* series on moist sites, and herb-sparse *Abies concolor* habitat types on dry sites.

Comments.—Timber productivity is generally limited by the rigorous subalpine environment. Lower elevation sites have the highest timber potentials. Timber management at low elevations may favor either *Picea engelmannii* or *Pseudotsuga menziesii*. However, caution is necessary when managing for *P. menziesii* because frost damage to regeneration may be severe. Wet habitats within the series require special care during timber harvests to prevent severe soil compaction, erosion, raising of the water table, and conversion to sedge communities.

Heavy snow accumulations within the series indicate that the sites have a high potential for water production. Also, the esthetics of forests in the *Abies lasiocarpa* series make them valuable for recreation. Because the rate of recovery following major disturbance is slow (Pfister 1976), heavy timber harvests could affect recreational use for long periods.

Domestic forage production is generally poor except in localized valley bottom sites. Big game species utilize forests and adjacent nonforested communities as summer range.

Fire has played a major role in the ecology of portions of this series, as evidenced by extensive *Populus tremuloides* stands. The large areas of such seral communities, often perpetuated by a scant conifer seed source, are visual evidence of alteration by fire that can persist for decades or even centuries (Steele et al. 1981). Snow avalanches often occur at upper elevations, and result in mosaics of varying stages of forest development.

Abies lasiocarpa/Mertensia ciliata **habitat type (ABLA/MECI; subalpine fir/tall mertensia)**

This habitat type is restricted to wet seep slopes high in the San Juan and Sangre de Cristo Mountains.

Vegetation.—*Picea engelmannii* and *Abies lasiocarpa* codominate the overstory. The most conspicuous feature of the vegetation in this type is not the overstory but the undergrowth (fig. 5). Total herb cover in excess of 100% is common. Often five or more species will be abundantly represented in the undergrowth. Species lists commonly exceed 50 taxa within a given plot. Thus, richness and luxuriant herbaceous growth characterize this type. The undergrowth is patchy, reflecting variations in soil moisture.

Dominant wet-site species having a high fidelity for this type include: *Carex bella* and other wet-site carices; and such forbs as *Caltha leptosepala*, *Cardamine cordifolia*, *Erigeron coulteri*, *Geranium richardsonii*, *Ligusticum porteri*, *Mertensia ciliata*, *Mitella pentandra*, *Oxypolis*

[8]*Hess, Karl, and C. H. Wasser. 1982. Habitat type classification of a part of the White River-Arapaho National Forest. Draft Report, 190 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

fendleri, Saxifraga odontoloma, Senecio triangularis, and *Streptopus amplexifolius.* Dry hummocks, such as around tree bases, support *Vaccinium* spp. and *Polemonium pulcherrimum* ssp. *delicatum.*

Physical setting.—Slopes are typically gentle to moderate and aspects are generally northerly. Elevations vary from 9,200 to 11,200 feet (2,800 to 3,410 m). Topographic positions on which this type occur typically are lower and mid slopes. Soils are characteristically deep and exhibit high water tables. Soil subgroups include Aquic Cryoboralfs, Argiaquic Cryoborolls, Argic Pachic Cryoborolls, and Aquic Cryofluvents.

Adjacent habitat types.—Commonly, where seeps emerge in areas dominated by the PIEN/VAMY/POPU HT, the ABLA/MECI HT occupies the seep areas. Wet meadows dominated by *Carex* spp. and *Juncus* spp. adjoin the type in some areas.

Comments.—This habitat type represents the wettest nonriparian conditions of the southern Rocky Mountains, resulting in long intervals between fires. The typically sheltered topographic position reduces the occurrence of extensive windthrow. Thus, many forests of this type exhibit climax conditions (Peet 1981).

Typically, seep areas are a minor component of the landscape, and habitat types associated with them would likely have little importance in management. However, some high-elevation areas have extensive seep slopes where the fragile aquic soils make conventional silvicultural operations difficult. Skidding of logs can compact the soil and accelerate erosion. Use of heavy equipment can be particularly damaging in the spring and early summer when water tables are highest. Furthermore, clearcutting often results in the formation of dense *Carex* communities that are unsuitable for conifer establishment without considerable site preparation. Steele et al. (1981) suggest that removal of the overstory may raise the water table, severely hindering regeneration.

Figure 5.—*Abies lasiocarpa/Mertensia ciliata* habitat type, San Juan Mountains.

The abundant forage and proximity to streams attract livestock; as a result, compaction of the wet soil and loss of plant cover may be severe. Wildlife use also may be high because abundant food and cover are present for elk, deer, and black bear; also, wet spots are available for elk and bear to wallow. This habitat type is an important water producer.

Dix and Richards (1976) presented data from two plots near Wolf Creek Pass in the San Juan Mountains of Colorado that may be classified as the ABLA/MECI HT. The type is approximately synonymous with the *Abies lasiocarpa/Senecio triangularis* habitat type described in Idaho by Steele et al. (1981). Peet (1981) described a wet *Picea-Abies* forest community in northern Colorado that is equivalent to the ABLA/MECI HT. Steele et al. (1981) and Pfister et al. (1977) described an *Abies lasiocarpa/Calamagrostis canadensis* habitat type that has affinities to the type described here. In addition, Steele et al. (1981) reported closely related *Abies lasiocarpa/Streptopus amplexifolius* and *Abies lasiocarpa/Caltha biflora* habitat types.

Abies lasiocarpa/Moss habitat type (ABLA/Moss; subalpine fir/moss)

This habitat type is restricted primarily to the Sangre de Cristo, San Pedro, and Jemez Mountains of northern New Mexico.

Vegetation.—*Picea engelmannii* and *Abies lasiocarpa* typically codominate the overstory, and *Populus tremuloides*, or occasionally *Pinus aristata*, are minor seral trees. At lower elevations in this habitat type, elements of the mixed conifer zone appear, as evidenced by a *Pseudotsuga menziesii* seral component and the presence of *Acer glabrum*. Vascular plants are minor in the undergrowth of this comparatively dry habitat type (fig. 6). *A. glabrum, Juniperus communis,* or *Vaccinium* spp. occasionally attain 10% cover. *Vaccinium caspitosum* was found to be an important diagonostic species in northern New Mexico (Moir and Ludwig 1979); however, moss cover is the only prominent feature of the undergrowth. The sparseness of the undergrowth in this type relates to the generally severe character of the sites.

Physical setting.—Elevations range from 9,800 to 11,500 feet (2,990 to 3,500 m) and slopes vary from gentle to steep. Generally, the type occurs on ridges or upper slopes on any aspect.

Adjacent habitat types.—The ABLA/Moss HT lies within the elevational range of the PIEN/VAMY/POPU and the ABLA/VAMY HT's and adjoins them in less exposed situations.

Comments.—The ABLA/Moss HT was first described as the *Picea engelmannii*/Moss habitat type by Moir and Ludwig (1979). Because *Abies lasiocarpa* is generally codominant with *P. engelmannii* in stands of this habitat type in northern New Mexico and southern Colorado, the type is here placed in the *A. lasiocarpa* series. Related vegetation includes the *Picea engelmannii, Pinus aristata, Trifolium dasyphyllum, Poa* habitat type (Shepherd[6]) and the *Pinus contorta* forest community of central Colorado (Peet 1981). Affinities also exist with the *Abies lasiocarpa/Juniperus communis* and the *Picea engelmannii/Hypnum revolutum* habitat types described in central Idaho (Steele et al. 1981). Dix and Richards (1976) provided data from one stand on Missionary Ridge in the San Juan Mountains of Colorado that is identifiable as the ABLA/Moss HT.

Timber productivity is low within this type and management alternatives are limited. Livestock find little forage and seldom use this habitat type, although it does provide cover for elk and deer that feed in adjacent habitat types.

Abies lasiocarpa/Vaccinium myrtillus habitat type (ABLA/VAMY; subalpine fir/myrtle blueberry)

This is one of the most widespread habitat types, not only in the southern Rockies, but throughout the high elevations of the Rocky Mountain system (Hoffman and Alexander 1980). The type is most poorly represented in that part of the Rockies where the oceanic climatic influence is strongest, for example, in eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968). The ABLA/VAMY HT occurs in all high mountains of northern New Mexico and southern Colorado. Its major importance in the study area is indicated by the fact that it is represented by 62 of the 234 *Picea engelmannii-Abies lasiocarpa* plots sampled.

Vegetation.—*Picea engelmannii* and *Abies lasiocarpa* codominate the climax overstory; few stands exhibit *Picea* dominance over *Abies. Pseudotsuga menziesii* and *Populus tremuloides* occur as seral trees in some stands.

Figure 6.—*Abies lasiocarpa*/Moss habitat type. The sparse undergrowth is characteristic of this type.

Figure 7.—*Abies lasiocarpa/Vaccinium myrtillus* habitat type, San Juan Mountains.

Pinus contorta is considered a major seral species in this type in most other areas in the Rockies (Daubenmire and Daubenmire 1968; Hess and Wasser;[8] Hoffman and Alexander 1976, 1980; Peet 1981; Pfister 1972; Pfister et al. 1977; Steele et al. 1981; Wirsing and Alexander 1975). In contrast, *P. contorta* was not found in any plots of this habitat type within the study area, even though it reaches its southernmost range in southern Colorado.

Vaccinium spp. dominate the undergrowth, but species diversity is typically low in drier portions of the habitat type. In moister situations, herbaceous species may attain high diversity and total coverage in excess of 30%. Dominant shrubs include *Acer glabrum, Lonicera involucrata, Mahonia repens, Orthilia secunda, Pachistima myrsinites, Ribes montigenum, Vaccinium scoparium,* and *V. myrtillus*. Common herbs are *Arnica cordifolia, Artemisia franseriodes, Bromopsis ciliata, Fragaria ovalis, Geranium richardsonii, Lathyrus* spp., *Oreochrysum parryi, Pedicularis racemosa,* and *Thalictrum. Erigeron eximius* is important in moist, warm sites and *Mertensia ciliata* in wet microsites throughout the type. High cover of *Vaccinium* spp. relative to other species is diagnostic for this type (fig. 7).

Physical setting.—Elevations range from 8,900 to 11,200 feet (2,710 to 3,410 m). The type occurs on all aspects and on moderate to steep slopes. Many south-facing slopes in this habitat type are burned-over and characterized by *Populus tremuloides* or other seral species (Moir and Ludwig 1979). Soil great groups represented include Cryoboralfs, Cryoborolls, Cryochrepts, and Cryorthents.

Adjacent habitat types.—This type adjoins the ABLA/Moss HT on drier exposures. The ABLA/VAMY-RUPA, ABLA/VAMY-LIBO, or the ABLA/EREX HT's commonly form the low-elevation ecotone with this type, while upper elevations support the PIEN/VAMY/POPU HT.

Comments.—In contrast to the PIEN/VAMY/POPU HT, tundra plants are generally absent and snowfall usually is not retained as long (Dix and Richards 1976). Also, in contrast to the PIEN/VAMY/POPU HT, *Populus tremuloides* is a major seral species. Undergrowths are

herb-rich beneath early-successional *Populus* canopies (Moir and Ludwig 1979). Dominant herbs can include *Bromopsis ciliata, Geranium richardsonii, Lathyrus* spp., *Thalictrum fendleri*, and *Thermopsis* spp.

This type, or the closely related *Abies lasiocarpa/Vaccinium scoparium* habitat type, has been described in the southern Rockies (Fitzhugh et al.[9]), in the central Rockies (Hess and Wasser;[8] Hoffman and Alexander 1976, 1980; Peet 1981; Pfister 1972; Wirsing and Alexander 1975), and in the northern Rockies (Daubenmire and Daubenmire 1968, Pfister et al. 1977, Steele et al. 1981). The environment and floristics of the ABLA/VAMY HT appear to be the same as that described in the literature for the *Abies lasiocarpa/Vaccinium scoparium* habitat type. Even where *Vaccinium myrtillus* is the only dominant *Vaccinium*, the environment of these cold, snowy forests is the same as the *V. scoparium* dominated areas in the central and northern Rocky Mountains. Both *V. myrtillus* and *V. scoparium* occur in many plant communities in the ABLA/VAMY HT; however, *V. myrtillus* was chosen in naming the habitat type as it is the more common of the two species in northern New Mexico and southern Colorado. The type is synonymous with the *Abies lasiocarpa/Vaccinium scoparium* habitat type described by Moir and Ludwig (1979).

The relationship between the ABLA/VAMY and the ABLA/EREX HT's is close. Shifts from a *Vaccinium*-dominated to an herb-dominated undergrowth probably reflect a gradient of increasing temperature (Moir and Ludwig 1979).

Timber productivity is low to moderate. *Abies* reproduction is generally heavier than *Picea* under tree canopies. Cutting will favor *Abies lasiocarpa* in the replacement stand (Hoffman and Alexander 1976). Wet variants of this type—as indicated by herb-rich conditions—appear to be converted to sedge fields following clearcutting, presenting severe regeneration problems. Drier areas exhibit slow changes in undergrowth vegetation following cutting, and competition is not severe between tree seedlings and the undergrowth (Hoffman and Alexander 1980).

The ABLA/VAMY HT characteristically provides poor grazing for livestock because of the short growing season, limited numbers of forage species, and low productivity resulting from shade associated with the generally continuous tree canopy (Steele et al. 1981). However, it does provide valuable summer range for big game. Summer recreational use may be high.

As with other high-elevation habitat types, one of the most important management considerations is the watershed value associated with the widespread and characteristically deep snowpack received by the habitat type (Leaf 1975).

[9]*Fitzhugh, E. Lee, William H. Moir, John A. Ludwig, and Frank Ronco, Jr. A classification of forest habitat types of the Apache, Gila, and Magdalena District, Cibola National Forests, Arizona and New Mexico. Manuscript in preparation. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.*

Abies lasiocarpa/Vaccinium myrtillus-Linnaea borealis habitat type (ABLA/VAMY-LIBO; subalpine fir/ myrtle blueberry-twinflower)

This habitat type is geographically widespread but topographically restricted. The type is most common in the San Juan Mountains of Colorado and in the Sangre de Cristo Range of Colorado and New Mexico.

Vegetation.—The ABLA/VAMY-LIBO HT is found at the ecotone of *Picea engelmannii-Abies lasiocarpa* and mixed conifer forests and, thus, supports many species common to both cover types. *Abies concolor, Pseudotsuga menziesii*, and *Populus tremuloides* are important seral trees. In Colorado, *Pinus contorta* sometimes occurs in seral stands. The wealth of tree species increases the difficulty of describing forest development following disturbance (Peet 1981). Typically, shrubs and forbs are abundant in the undergrowth, with *Vaccinium* spp. and *Linnaea borealis* the dominant indicators. In drier situations, however, *Rubus parviflorus* is dominant over *Linnaea borealis*. *Arnica cordifolia, Artemesia franseriodes, Erigeron eximius, Fragaria ovalis, Lathyrus* spp., *Oreochrysum parryi, Pachistima myrsinites*, and *Viola canadensis* often exhibit high coverage. Abundant moss cover indicates the moist conditions of this type (fig. 8).

Figure 8.—*Abies lasiocarpa/Vaccinium myrtillus-Linnaea borealis* habitat type, San Juan Mountains, at 8,950 feet (2,730 m).

Physical setting.—The habitat type occurs predominately on north- and northeast-facing mid and lower slopes in the *Abies lasiocarpa* series at elevations ranging from 8,700 to 9,800 feet (2,650 to 2,990 m). Soils include Cryoborolls, Cryoboralfs, and Cryorthents.

Adjacent habitat types.—The ABLA/VAMY-LIBO type shows affinities to both the ABLA/EREX and the ABLA/VAMY HT's, and adjoins them on warmer and colder sites, respectively. Lower elevations of similar topography may support the PIPU/LIBO HT.

Comments.—Moir and Ludwig (1979) described the *Abies lasiocarpa/Vaccinium myrtillus-Linnaea borealis* habitat type as the *Abies lasiocarpa/ Vaccinium scoparium/Linnaea borealis* habitat type. The name change from *Vaccinium scoparium* to *V. myrtillus* reflects the identification problems discussed earlier. The type is similar to the *Abies lasiocarpa/Linnaea borealis* habitat type in Montana (Pfister et al. 1977) and in Idaho (Steele et al. 1981), which also have a strong complement of *Vaccinium*. The *Picea engelmannii-Abies lasiocarpa/Pachistima myrsinites* habitat type (Hess and Wasser[8]) and the mixed mesic forest community (Peet 1981) of central Colorado are also similar to the ABLA/VAMY-LIBO HT described here.

Timber productivity is moderate. Either *Picea engelmannii* or *Pseudotsuga menziesii* may be considered for timber management. When the type is being managed for *Pseudotsuga*, frost damage may be severe (Pfister et al. 1977).

Although grass production is limited, the value for domestic grazing of forbs may be moderate. Diverse shrub and forb layers typically provide good big game browse. *Vaccinium* fruits may be important feed for grouse and black bear. Water yield is quite high.

Abies lasiocarpa/Vaccinium myrtillus-Rubus parviflorus habitat type (ABLA/VAMY-RUPA; subalpine fir/ myrtle blueberry-thimbleberry)

This habitat type occurs in cool, moist, lower elevations within the *Abies lasiocarpa* forests of Colorado's San Juan Mountains.

Vegetation.—*Abies lasiocarpa* and *Picea engelmannii* codominate the climax overstory. *Pseudotsuga menziesii* and *Populus tremuloides* are the most important seral trees. Undergrowths are diverse and total canopy cover commonly exceeds 100%. Dominant shrubs include *Lonicera involucrata, Pachistima myrsinites, Rubus parviflorus,* and *Vaccinium* spp. (fig. 9). Characteristic herbs are *Arnica cordifolia, Bromopsis ciliata, Erigeron eximius, Geranium richardsonii, Oreochrysum parryi,* and *Smilacina racemosa.*

Physical setting.—The habitat type most commonly occurs on relatively moist, steep, northerly, lower slopes in the 8,800 to 9,700 foot (2,680 to 2,960 m) elevation range. Soils are primarily Typic Cryoboralfs.

Adjacent habitat types.—The ABLA/VAMY-RUPA HT adjoins at higher elevations, while the ABLA/RUPA HT or cool-moist mixed conifer habitat types are encountered at lower elevations.

Figure 9.—*Abies lasiocarpa/Vaccinium myrtillus-Rubus parviflorus* habitat type, San Juan Mountains. It features shrub- and herb-rich undergrowths.

Comments.—The ABLA/VAMY-RUPA HT is closely related to the warmer ABLA/RUPA HT described in this report and in southwestern New Mexico by Fitzhugh et al.[9] and Moir and Ludwig (1979). The type is characteristic of those forests in the southwestern United States receiving the highest growing season precipitation (Moir and Ludwig 1979).

Abies lasiocarpa/Rubus parviflorus habitat type (ABLA/RUPA; subalpine fir/thimbleberry)

This habitat type is restricted to relatively moist portions of Colorado's San Juan Mountains.

Vegetation.—Both *Abies lasiocarpa* and *Picea engelmannii* dominate the climax overstory. *Pseudotsuga menziesii* and *Populus tremuloides* are major seral species.

Undergrowths are rich in species diversity, which is suggestive of mesic conditions, and are similar in appearance to those of the ABLA/VAMY-RUPA HT, except that *Vaccinium* spp. are lacking. Dominant shrubs include *Acer glabrum, Lonicera involucrata, Pachistima myrsinites,* and *Rubus parviflorus.* Common herbs are *Arnica cordifolia, Artemisia franseriodes, Erigeron eximius, Geranium richardsonii, Lathyrus* spp., *Ligusticum porteri, Smilacina stellata,* and *Thalictrum fendleri.*

Physical setting.—The ABLA/RUPA HT most commonly occurs on steep, northerly, lower slopes in the 8,900 to 9,800 foot (2,710 to 2,990 m) elevation range. Soils are predominantly Typic Cryoboralfs and Argic Cryoborolls.

Adjacent habitat types.—At lower elevations, this habitat type commonly adjoins the ABCO/ACGL HT. The common ecotones at higher elevations are with either the ABLA/VAMY or the ABLA/VAMY-LIBO HT's. The ABLA/EREX HT occurs on rather similar wet locations.

Comments.—The ABLA/RUPA HT is characteristically moist. It has been previously described in the Mogollon Mountains of southern New Mexico by Moir and Ludwig (1979) and Fitzhugh et al.[9] Both the San Juan and Mogollon Mountains receive high precipitation, which may explain the occurrence of *Rubus parviflorus* in both areas.

Slopes are generally too steep to be harvested by conventional logging techniques or grazed by domestic stock. Water yield and big game utilization are generally high.

Abies lasiocarpa/Erigeron eximius habitat type (ABLA/EREX; subalpine fir/forest fleabane)

This habitat type is widespread throughout the mountains of southern Colorado and northern New Mexico.

Vegetation.—*Pseudotsuga menziesii, Populus tremuloides*, and *Abies concolor* generally occur as seral trees within this type. When *Vaccinium* spp. are present, they are minor relative to *Erigeron eximius* (fig. 10). Species that often typify the characteristically shrub- and herb-rich undergrowth include: shrubs—*Lonicera involucrata, Pachistima myrsinites*, and *Ribes montigenum*; grasses—*Bromopsis ciliata*; and forbs—*Arnica cordifolia, Fragaria ovalis, Geranium richardsonii, Mertensia ciliata, Oreochrysum parryi, Thalictrum fendleri*, and *Viola canadensis*.

Physical setting.—The absence or minor occurrence of *Vaccinium* spp. suggests a moister nature and generally warmer than normal temperature for the *Abies lasiocarpa* series. This type occurs on all but the driest south-facing aspects, and on all landscape positions, other than ridgetops, at elevations of 9,200 to 10,500 feet (2,800 to 3,200 m). Slopes vary from gentle to very steep. Soils typically have argillic horizons and are Cryoboralfs or Cryoborolls. Occasionally, Cryorthents occur.

Figure 10.—*Abies lasiocarpa/Erigeron eximius* habitat type, San Juan Mountains. The tree supporting the scale-reference rod is approximately 39 inches (1 m) in diameter.

Adjacent habitat types.—On cooler and drier sites it adjoins *Vaccinium* dominated types. It intergrades with the ABCO/EREX HT at lower elevations. Often the type occurs in frost pockets within the elevational range of the *Abies concolor* series. Such frost pockets favor growth of *Abies lasiocarpa* and *Picea engelmannii* (Daubenmire and Daubenmire 1968).

Comments.—Fire has played a major role in the ABLA/EREX HT and extensive *Populus tremuloides* stands now occur within it. The undergrowth in these *Populus* communities is rich in forbs.

Among the habitat types of the *Abies lasiocarpa* series, overgrazing tends to occur most frequently in this type. Unlike situations in other habitat types in the series, *Poa pratensis* sod may develop in the ABLA/EREX HT in response to heavy livestock grazing. Large volumes of browse for elk and deer are produced.

As with most of the *Abies lasiocarpa* series, high precipitation and snowpack accumulation give this habitat type a high watershed value. Timber productivity ranges from moderate to high. The presence of *Pseudotsuga* as an important seral tree (minor climax in some areas) provides flexibility for timber management and opportunities for developing mixed species stands.

The *Abies lasiocarpa/Erigeron eximius* habitat type has previously been described as the *Abies lasiocarpa/Erigeron superbus* habitat type by Moir and Ludwig (1979). In this report, and in Fitzhugh et al.,[9] the name *Erigeron superbus* has been changed to *E. eximius* based on the nomenclature of Weber and Johnston (1979). The *Abies lasiocarpa/Lathyrus arizonica* habitat type of northern Arizona (Moir and Ludwig 1979) is similar to the ABLA/EREX HT described here. Weakly similar habitat types occur throughout the Rocky Mountains. An *Abies lasiocarpa/Berberis repens* habitat type has been reported in Utah that is identifiable with the ABLA/EREX HT (Pfister 1972). Peet (1981) describes a similar montane ravine forest community in Rocky Mountain National Park, Colorado. *Abies lasiocarpa/Clintonia uniflora* and *Abies lasiocarpa/Pachistima myrsinites* habitat types in the northern Rockies occur in environments similar to those described here (Daubenmire and Daubenmire 1968, Pfister et al. 1977, Steele et al. 1981).

Picea pungens Series

This series is restricted to cold-moist environments throughout the mixed conifer zone. Although widespread geographically, the areal extent of the *Picea pungens* series is relatively minor since topoedaphic features—sheltered slopes, frost pockets and perennially moist soils—conducive to development of *P. pungens* dominated forests form a minor component of the landscape.

Vegetation.—As a rule, overstories of the *Picea pungens* series are highly mixed. In frost pockets, *Abies lasiocarpa* and *Picea engelmannii* occur as minor components of many stands, as in the PIPU/LIBO HT, while comparatively warm sites include *Pinus ponderosa*, as in the PIPU/FEAR HT. *Pseudotsuga menziesii* is typically codominant with *Picea pungens*, while *Abies concolor* and *Pinus flexilis* are typically of secondary importance or absent. *Populus tremuloides* is the major tree species of seral stands.

The generally favorable moisture conditions result in a rich species mixture within this series. Moist sites are dominated by such forb species as *Artemisia franseriodes*, *Erigeron eximius*, *Fragaria americana*, *Oreochryrum parryi*, and *Thalictrum fendleri*, while drier sites exhibit a rich assortment of graminoids, including *Carex foenea*, *Danthonia parryi*, *Festuca arizonica*, *Muhlenbergia montana*, and *Poa fendleriana*.

Physical setting.—Examples of this series are most frequently encountered on lower slopes protected from extreme sun and wind. Elevations range from 7,900 to 9,200 feet (2,400 to 2,800 m). Soils are highly varied but are rarely lithic. Cryic soils are encountered in the PIPU/LIBO HT and occasionally in the PIPU/EREX HT, while all other habitat types in the series are represented by frigid, udic soils.

Adjacent habitat types.—Depending on elevation, the moist habitat types in the *Picea pungens* series adjoin herb-rich habitat types in the *Abies lasiocarpa* and *Abies concolor* series. Drier habitats in the series are adjacent to graminoid dominated habitats in the *A. concolor* series.

Comments.—Pfister (1972) questioned the successional status of *Picea pungens*. He suggested that where *P. pungens* occurs in association with *Abies lasiocarpa* or *A. concolor*, it must be considered seral because it is the least shade-tolerant of the three species. In this study, *P. pungens* was occasionally present and reproducing successfully even in stands containing a complement of *Abies* spp., and no evidence was found to suggest the eventual elimination of *P. pungens*. Consequently, the recognition of a *Picea pungens* climax series is justified, especially since *P. pungens* appears to be indicative of specific environmental conditions.

Heavy disturbance by both grazing and fire is widespread in this series. Careful evaluation of successional *Populus tremuloides* forests may suggest placing them in the *Picea pungens* series, depending on the presence or absence of *P. pungens* regeneration.

Management options vary widely within this series. Timber productivity is moderate and *Picea engelmannii*, *Pseudotsuga menziesii*, and *Pinus ponderosa* may all be considered for management. Domestic forage production ranges from low in the PIPU/LIBO HT to high in the PIPU/FEAR HT, and big game forage is good throughout the series. Snow accumulations are often significant and serve to heighten watershed opportunities within the series. Scenic attributes are important because the characteristic lower slope positions of the series are near roads, trails, and campgrounds.

Figure 11.—***Picea pungens/Linnaea borealis*** **habitat type, San Juan Mountains. In this plot, moss cover is high (60%).**

Picea pungens/Linnaea borealis habitat type (PIPU/LIBO; Colorado blue spruce/twinflower)

This rare habitat type was found only in the northern Sangre de Cristo Range in New Mexico and in the San Juan Mountains of Colorado.

Vegetation.—*Picea pungens* and *Pseudotsuga menziesii* codominate the overstory. *Pinus flexilis* and *Abies concolor* commonly occur. The successional status of *A. concolor* in this habitat type is uncertain. *A. lasiocarpa* and *Picea engelmannii* occur as minor components of some stands in frost pockets.

Favorable moisture conditions result in a rich assemblage of shrub and herb species within this habitat type (fig. 11). In addition to abundant *Linnaea borealis*, other shrubs characterizing the undergrowth include *Juniperus communis*, *Pachistima myrsinites*, *Rubus parviflorus*, and *Vaccinium* spp. Graminoids and forbs such as *Artemisia franseriodes*, *Carex foenea*, *Erigeron eximius*, *Fragaria* spp., *Lathyrus* spp., *Orthilia secunda*, and *Thalictrum fendleri* also are commonly found in the undergrowth.

Physical setting.—The PIPO/LIBO HT is encountered most commonly on steep, northerly, lower slopes protected from extreme sun and wind between elevations of 8,200 to 9,200 feet (2,500 and 2,800 m). Soils include Cryoborolls and Cryochrepts.

Adjacent habitat types.—The PIPU/LIBO HT commonly adjoins such species-rich habitat types as ABLA/EREX, ABLA/VAMY-LIBO, or ABLA/RUPA.

Comments.—This is the most mesic of the *Picea pungens* habitat types. Previously, Moir and Ludwig (1979) described this type as a phase of a *Picea pungens-Pseudotsuga menziesii* habitat type. The phase was upgraded to habitat type status after further sampling clearly indicated its distinctiveness. In the northern Rockies, outside the range of *Picea pungens*, the *Picea/Linnaea borealis* habitat type described by Pfister et al. (1977) is weakly related to the *Picea pungens/Linnaea borealis* habitat type described here.

Forage production is poor for domestic stock but good for deer and elk. Timber productivity is moderate. Heavy winter snow accumulations limit access.

Picea pungens/Erigeron eximius habitat type (PIPU/EREX; Colorado blue spruce/forest fleabane)

This habitat type occurs in all major mountain ranges within the study area.

Vegetation.—Overstories are similar to those of the PIPU/LIBO HT. *Abies lasiocarpa* and *Picea engelmannii* are less frequent associates, however, as the sites are generally warmer than those delineated by *Linnaea borealis*.

Typically, the undergrowth is highly variable in both composition and total cover. The moist nature of the habitat type is characterized by high forb cover, in which *Erigeron eximius* is diagnostic (fig. 12). In drier situations no diagnostic species occur with consistently high cover, but *Fragaria americana* and *Oreochrysum parryi* are common. Graminoid cover is characteristically low throughout the type except that Carex foenea is occasionally well represented. Further investigation may yield data in support of distinguishing phases within this varied habitat type.

Physical setting.—The PIPU/EREX HT occurs at elevations ranging from 8,200 to 9,200 feet (2,500 to 2,800 m) on moderate to steep lower slopes. This type may be expected on any slope exposure. Soils vary from Typic Udorthents to Eutric Glossoboralfs.

Figure 12.—*Picea pungens/Erigeron eximius* habitat type, San Juan Mountains. The undergrowth species composition is mesophytic herbs.

Figure 13.—A *Picea pungens/Carex foenea* habitat type, Jemez Mountains, with a well-developed undergrowth dominated by graminoids (50% cover of *C. foenea* in this plot).

Adjacent habitat types.—Lower elevation ecotones are with the ABCO/EREX HT, while at higher elevations, ecotones are formed with the ABLA/EREX HT.

Comments.—Heavy disturbance by both grazing and fire make plot selection difficult in this type. The type is widespread, however, and careful evaluation of successional forests, largely *Populus tremuloides* forb-rich communities, within the range of this type is necessary to determine the correct habitat type. Particular attention should be paid to the presence or absence of *Picea pungens* regeneration.

The *Picea pungens/Erigeron eximius* habitat type of southern New Mexico and Arizona was described by Fitzhugh et. al.[9] Similarly, affinities occur with the *Picea pungens-Picea engelmannii/Erigeron superbus* habitat type described in the White Mountains of Arizona (Moir and Ludwig 1979), except that *P. engelmannii* is a relatively minor component of the PIPU/EREX HT in northern New Mexico and southern Colorado.

The lower slope position of this type places it adjacent to many roads, trails, and campgrounds. Thus, the habitat type has important scenic qualities.

Picea pungens/Carex foenea habitat type (PIPU/CAFO; Colorado blue spruce/spruce sedge)

This minor habitat type occurs in the Jemez Mountains of New Mexico and the San Juan Mountains of Colorado.

Vegetation.—Overstories typically exhibit codominance of *Picea pungens* and *Pseudotsuga menziesii*, with *Pinus ponderosa* important in some stands as a seral species. *Abies concolor* generally is absent or minor. Undergrowths are characterized by abundant *Carex foenea* and often high coverage of *Fragaria* spp. and *Geranium richardsonii* (fig. 13).

Physical setting.—This habitat type occurs on northerly facing canyon sideslopes at elevations of 8,500 to 9,000 feet (2,590 to 2,740 m). Slope steepness typically is gentle to moderate. Dominant soils are Typic Dystrandepts.

Adjacent habitat types.—Adjoining habitat types are PIPU/FEAR at lower elevations and PIPU/EREX or ABCO/ACGL at higher elevations. The type often borders grassy meadows.

Comments.—As with other habitat types that support high cover of palatable graminoids, the PIPU/CAFO HT often is used by grazing animals. The generally moderate terrain and close proximity to water further promote grazing use. Many stands are within summer grazing allotments. The type is relatively minor in areal extent and therefore is probably less important for management. Moir and Ludwig (1979) previously described this type.

Pseudotsuga menziesii and *Pinus ponderosa* are important commercial trees occurring within this type; however, growth is moderate at best.

Picea pungens/Arctostaphylos uva-ursi habitat type (PIPU/ARUV; Colorado blue spruce/kinnikinnik)

This is a minor habitat type, occurring primarily in the San Juan Mountains.

Vegetation.—*Picea pungens, Pseudotsuga menziesii,* and *Pinus ponderosa* frequently codominate in the overstory. Occasionally, *Abies concolor* and *Pinus flexilis* are also important. *Arctostaphylos uva-ursi* is the characteristic understory dominant and *Festuca arizonica, Fragaria ovalis,* and *Juniperus communis* are frequently important (fig. 14).

Physical setting.—The PIPU/ARUV HT occurs on warm, dry, moderately steep, south slopes and ridges at elevations of 7,900 to 9,200 feet (2,410 to 2,800 m). It seldom is found on midslopes.

Adjacent habitat types.—Warmer sites merge to the PIPU/FEAR or the ABCO/ARUV HT, while cooler site ecotones are with the PIPU/CAFO HT.

Comments.—Moir and Ludwig (1979) previously described this type as the *Arctostaphylos uva-ursi* phase of their *Picea pungens-Pseudotsuga menziesii* habitat type. The distinctiveness of the PIPU/ARUV HT, as observed by further sampling in northern New Mexico and southern Colorado, supported raising the phase to the habitat type level. Within the *Picea pungens* series, only the PIPU/FEAR HT is characteristically found in warmer, drier situations.

Figure 14.—*Picea pungens/Arctostaphylos uva-ursi* habitat type, San Juan Mountains. *A. uva-ursi* and *Juniperus communis* are well represented in this plot.

Figure 15.—*Picea pungens/Festuca arizonica* habitat type, San Juan Mountains. As shown here, stands are open, allowing the shade-intolerant *F. arizonica* to dominate the undergrowth.

Picea pungens/Festuca arizonica habitat type (PIPU/FEAR; Colorado blue spruce/Arizona fescue)

This habitat type occurs primarily in the Jemez Mountains of New Mexico and in the San Juan Mountains of Colorado.

Vegetation.—Overstories are similar to those described for the PIPU/ARUV HT. Undergrowths are characterized by high cover of a rich assortment of graminoids (fig. 15). *Carex foenea, Danthonia parryi, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana,* and *Sitanion hystrix* are found in most plots. Important forbs include *Erigeron formosissimus, Fragaria* spp., *Lathyrus* spp., and *Potentilla hippiana.*

Physical setting.—In contrast to the PIPU/CAFO HT on northerly slopes, this type generally occurs on warmer southwesterly slopes. Elevations vary from 8,200 to 9,200 feet (2,500 to 2,800 m) and slopes are moderate to steep. Soil subgroups are highly varied and include Udic Argiborolls and Haploborolls, Lithic Haploborolls,

Eutric Glossoboralfs, Typic Dystochrepts, and Andeptic Udorthents.

Adjacent habitat types.—The ABCO/FEAR HT is encountered in slightly drier situations and the PIPU/CAFO or the ABCO/CAFO HT's in more mesic areas.

Comments.—The *Picea pungens/Festuca arizonica* habitat type, was also reported in southern Arizona and New Mexico (Fitzhugh et al.[9]). The PIPU/FEAR HT represents the warmest and driest of *P. pungens* dominated forests. It is moderately extensive, particularly when considered in combination with the closely related ABCO/FEAR HT. The high palatability of *Festuca arizonica* makes forage management an important consideration in this type.

Abies concolor Series

The *Abies concolor* series occurs at mid-elevations and is the most widespread mixed conifer series.

Vegetation.—Overstories are highly mixed, sometimes with seven coniferous species growing together in the same stand—*Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus flexilis, Pinus ponderosa,* and *Pseudotsuga menziesii*. However, the presence and relative proportion of these species depends on moisture-temperature relationships. In all cases, more successful reproduction of *A. concolor* is diagnostic of this series. Early seral communities are dominated by *Populus tremuloides* in mesic situations, and by *Quercus gambelii* on comparatively xeric sites.

The undergrowth is also highly variable. Among the diagnostic species, *Vaccinium* spp. occurs on cold sites, *Festuca arizonica* on warm sites, *Quercus gambelii* on dry sites, and *Erigeron eximius* on moist sites. Stands rich in shrubs, herbs, graminoids, or with depauperate undergrowths such as the ABCO/Sparse HT, are all represented in this series. Undergrowths may resemble those of the *Pseudotsuga menziesii* series on dry sites or the *Abies lasiocarpa* series on cold sites.

Physical setting.—Elevations range from 7,900 to 10,200 feet (2,410 to 3,110 m). Settings vary from cold-moist sites having cryic soils to warm-dry sites having frigid-udic soils.

Adjacent habitat types.—The *Abies concolor* series exhibit the most complex ecotones of any forested series in the study area (Layser and Schubert 1979). At upper elevations, the series grades to the *Abies lasiocarpa* series, while cool-moist sites at the same elevation feature the *Picea pungens* series. Lower elevation sites support the *Pseudotsuga menziesii* series and on the most xeric sites the *Pinus ponderosa* series.

Comments.—Management options are varied within the *Abies concolor* series. Timber productivity may be high for *Pseudotsuga menziesii* in the ABCO/EREX HT. Grazing opportunities for domestic stock are maximized in the ABCO/FEAR HT. Big game utilization may be exceptionally high in the ABCO/ACGL HT. Heavy snow accumulation will produce high water yields in the ABCO/VAMY HT. Varied topographical and biological conditions within the series add to the esthetics.

Basically, the *Abies concolor* series is ecologically similar to the *Abies grandis* series of the northern Rocky Mountains described by Pfister et al. (1977) and Steele et al. (1981). Both the *A. concolor* and the *A. grandis* series lie between the drier *Pseudotsuga menziesii* series and the cooler *A. lasiocarpa* series.

Fire is a major influence in maintaining many plant communities in this series. *Abies concolor* is relatively susceptible to fire (Brown and Davis 1973) and is more highly shade-tolerant than *Pinus ponderosa* and *Pseudotsuga menziesii* (Baker 1950). Thus, many habitat types within the *A. concolor* series are dominated by *Pinus ponderosa* and *Pseudotsuga menziesii* in mid-seral stages, with *A. concolor* steadily gaining dominance as succession proceeds.

Abies concolor/Vaccinium myrtillus habitat type (ABCO/VAMY; white fir/myrtle blueberry)

This minor habitat type occurs in the San Juan, Sangre de Cristo, and Jemez Mountains.

Vegetation.—Overstories are highly mixed, with some stands comprised of up to seven species, including *Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus flexilis, Pinus ponderosa,* and *Pseudotsuga menziesii*.

Acer glabrum, Amelanchier alnifolia, Arctostaphylos uva-ursi, Mahonia repens, Pachistima myrsinites, Rubus parviflorus, and *Symphoricarpos oreophilis* are shrubs that often codominate the conspicuous *Vaccinium* spp. layer of the undergrowth (fig. 16). Among the many forb species usually present are *Erigeron eximius, Fragaria ovalis,* and *Lathyrus* spp.

Physical setting.—This habitat type occurs at approximately 8,500 to 9,200 feet (2,590 to 2,800 m), which is below the elevational limits of *Abies lasiocarpa* and *Picea engelmannii* dominance. It occurs on steep, cold, northerly slopes. Soils are Cryochrepts, Cryoborolls, and Cryorthents.

Adjacent habitat types.—The ABCO/VAMY HT type adjoins ABLA/VAMY stands at higher elevations and herb-rich mixed conifer stands at lower elevations.

Comments.—This type is found on the coldest sites in the *Abies concolor* series. Because of the infrequent occurrence of the type, it is relatively unimportant for management. *Pseudotsuga menziesii* could be favored in timber management, but *P. menziesii* dominance would be difficult to maintain in such a mixed conifer environment.

Livestock forage production potential is low. Big game browse may be heavy, and thinning the overstory will increase shrub cover.

The ABCO/VAMY HT has not been described previously in the southern Rocky Mountains. However, it is closely related to the *Pseudotsuga menziesii/Pachistima myrsinites* habitat type described in the central Rockies (Hoffman and Alexander 1980) and weakly related to *Abies grandis* and *Pseudotsuga menziesii/Vaccinium globulare* habitat types of the northern Rockies (Pfister et al. 1977, Steele et al. 1981).

Abies concolor/Erigeron eximius habitat type (ABCO/EREX; white fir/forest fleabane) Mexico

This type is relatively rare in Colorado, but is common in the Jemez Caldera region and the Sangre de Cristo Range of New Mexico.

Vegetation.—Overstories are highly complex. *Abies concolor* and *Pseudotsuga menziesii* codominate, but *Picea pungens* and *Pinus flexilis* may be important. In frost pockets, *Abies lasiocarpa* and *Picea engelmannii* also may occur. *Pinus ponderosa* is accidental or minor. Seral communities are dominated by *Populus tremuloides*.

The ABCO/EREX HT is a herb-rich habitat type (fig. 17). *Artemisia franseriodes, Bromopsis ciliata, Carex foenea, Erigeron eximius, Fragaria* spp., *Lathyrus* spp., *Oreochrysum parryi*, and other moist-site herbs exhibit characteristically high cover values. Relative to the closely related ABCO/ACGL HT, shrubs are generally less important. Canopy removal may cause substantial increases in shrub coverage. Distinguishing the ABCO/EREX HT from the ABCO/ACGL HT on seral sites is difficult. However, herb-richness is diagnostic of the *Erigeron* type.

Physical setting.—All slopes, aspects, and landforms other than ridges are represented, but elevations cluster narrowly between 9,200 and 9,500 feet (2,800 and 2,900 m). Sites are moist and protected from extreme sun and wind. Soils include Haploborolls and Dystrochrepts.

Figure 16.—*Abies concolor/Vaccinium myrtillus* habitat type, San Juan Mountains.

Figure 17.—*Abies concolor/Erigeron eximius* habitat type, San Juan Mountains. Herb and sub-shrub diversity and cover are high, with *E. eximius* up to 30%.

Adjacent habitat types.—The major ecotone is with the ABCO/ACGL HT. The two types intergrade, with the *Erigeron* type generally found on deeper soils.

Comments.—Moir and Ludwig (1979) originally described this type as the *Abies concolor-Pseudotsuga menziesii/Erigeron superbus* habitat type. To shorten the name, *Pseudotsuga menziesii*, the less shade tolerant of the two trees, was dropped. Also, to reflect the revised taxonomy of Weber and Johnston (1979), *Erigeron superbus* was changed to *E. eximius*. Fitzhugh et al.[9] have recognized this as a distinct type in southern Arizona and New Mexico. General site characteristics are weakly comparable with *Abies grandis/Clintonia uniflora* habitat type of Montana and central Idaho (Pfister et al. 1977, Steele et al. 1981).

Timber productivity may be high for *Pseudotsuga*. Livestock find little forage except in early successional stands. However, wildlife browse is favorable except in winter when heavy snow accumulations limit access.

Abies concolor/Acer glabrum habitat type (ABCO/ACGL; white fir/Rocky Mountain maple)

The type occurs throughout the study area except for the Dolores Mesa area, which is located at the western

edge of the San Juan Mountains of Colorado and is outside the range of *Abies concolor*.

Vegetation.—Tree species present are the same as those found in the ABCO/EREX HT. Shrubs dominate the undergrowth (fig. 18). *Acer glabrum*, *Amelanchier alnifolia*, *Jamesia americana*, *Mahonia repens*, *Pachistima myrsinites*, *Physocarpus monogynus*, and *Symphoricarpos oreophilus* often have high cover values. Although typically lower in cover, many of the same herbs are found in the ABCO/ACGL HT as in the ABCO/EREX HT.

Physical setting.—This is one of the most varied types with respect to topographic and vegetational characteristics. All slope aspects are represented, and elevations span from 8,200 to 9,850 feet (2,500 to 3,000 m). The type occurs predominantly on lower slopes, but many examples can be found on mid and upper slopes.

This type typically occurs on relatively shallow, often skeletal, soils on very steep slopes. Borolls, Boralfs, and Ochrepts were all sampled within the type.

Adjacent habitat types.—The ABCO/ACGL HT intergrades to ABCO/EREX HT in more mesic areas and to the ABCO/QUGA HT in more xeric situations. The type forms a lower elevation limit of many subalpine species.

Comments.—This type is one of the most widespread in the mixed conifer forest. It has previously been described in many forests in Arizona and New Mexico

Figure 18.—*Abies concolor/Acer glabrum* habitat type, San Juan Mountains. *A. glabrum* is important in the undergrowth.

Figure 19.—*Abies concolor*/Sparse habitat type, San Juan Mountains. The sparse undergrowth cover shown is characteristic of this type.

(Alexander et al. 1984, Fitzhugh et al.,[9] Moir and Ludwig 1979) and is related to the *Pseudotsuga menziesii/Pachistima myrsinites* habitat type of central and northern Colorado (Hess and Wasser,[8] Hoffman and Alexander 1980). Weakly related types are represented by the foothill ravine forest community of Rocky Mountain National Park, Colorado (Peet 1981), and the *Abies grandis/Acer glabrum* habitat type of central Idaho (Steele et al. 1981).

Because of the cool, moist conditions characteristic of this habitat type, fires are mostly light, erratic, and infrequent (Moir and Ludwig 1979). The erratic nature of fires has resulted in mosaics in forest structure within this type.

Timber productivity is moderate. *Pseudotsuga menziesii* should regenerate well except when competition with shrubs is severe, which may be particularly significant when shrubs are released upon removal of the canopy.

Old-growth stands offer scant forage for livestock, and the typically steep slopes impede access. The type supplies prime forage and cover for big game. The shrubs provide abundant browse. Multistoried shrub layers increase microhabitat diversity for birds (Fitzhugh et al.[9]).

Abies concolor/Sparse habitat type (ABCO/Sparse; white fir/sparse undergrowth)

This habitat type is widespread within the study area.

Vegetation.—Overstories exhibit codominance of *Abies concolor* and *Pseudotsuga menziesii*. *Pinus flexilis*, *Pinus ponderosa*, *Picea pungens*, and *Juniperus scopulorum* are sometimes present.

Undergrowths are sparse, with only *Symphoricarpos oreophilos* ever attaining coverage in excess of 5% (fig. 19).

Physical setting.—This relatively dry habitat type occurs on canyon sideslopes and ridges of all aspects between the elevations of 8,200 and 9,850 feet (2,500 and 3,000 m). Slopes are steep to very steep. Soil suborders include Ochrepts, Borolls, Boralfs, and Orthents.

Adjacent habitat types.—Adjoining habitat types include ABCO/ACGL on moister sites and ABCO/QUGA on warmer sites. Cooler environments bordering this habitat type support forests dominated by *Abies lasiocarpa* habitat types.

Comments.—Management for all but water and wildlife is marginal as timber productivity and forage yields are low. In this study, some plots within the habitat type fit the description of the *Pseudotsuga menziesii/Physocarpus monogynus* habitat type described in northern New Mexico by Moir and Ludwig (1979). However, only two plots supported *Physocarpus* and furthermore, their site characteristics were closely comparable to those of other plots in the ABCO/Sparse HT. Thus, recognition of a distinct *Pseudotsuga menziesii/ Physocarpus monogynus* habitat type does not seem warranted at this time. Within such *Physocarpus*-dominated undergrowths, nevertheless, soils are invariably skeletal and site potential is exceptionally low.

The ABCO/Sparse HT has previously been described in Arizona and New Mexico (Alexander et al. 1984, Fitzhugh et al.,[9] Moir and Ludwig 1979). Weak similarities exist with xeric *Pseudotsuga* forest communities in northern Colorado (Peet 1981) and the *Pseudotsuga menziesii/Arnica cordifolia* habitat type described in the northern Rocky Mountains (Pfister et al. 1977, Steele et al. 1981).

In most cases, herb growth is likely limited by seasonal soil water deficits and shading (Moir and Ludwig 1979). Caution is necessary when keying to this habitat type since in some cases depauperate stages of other habitat types also may key to the ABCO/Sparse HT. Similarly, sparsity in other habitat types may result from intensive or prolonged wildlife browsing and grazing and should not be confused with normal sparseness in the ABCO/ Sparse HT.

Abies concolor/Arctostaphylos uva-ursi habitat type (ABCO/ARUV; white fir/kinnikinnik).

This type is of minor importance, but it occurs throughout the study area.

Vegetation.—Overstories are characterized by *Abies concolor* and *Pseudotsuga menziesii*, with *Pinus ponderosa* a major seral associate. *Arctostaphylos uva-ursi* dominates the undergrowth along with *Pachistima myrsinites* in some stands. Few other species ever attain 5% cover (fig. 20). *Arctostaphylos uva-ursi* cover is highest in sunlit openings.

Physical setting.—This type, seldom occurring on midslopes, is found most commonly on ridgetops and occasionally on lower slopes. Slopes are moderate to steep, facing all exposures. Elevations range from 7,900 to 9,500 feet (2,410 to 2,900 m). Soils are Typic Udorthents and Typic Dystrochrepts.

Adjacent habitat types.—The ABCO/ARUV HT represents a dry, cool environment within the zone of *Abies concolor-Pseudotsuga menziesii* codominance. In dry, warm situations *Pinus ponderosa* attains climax status within the range of *Arctostaphylos uva-ursi* and in dry, cold situations *Abies concolor* forests, with *Vaccinium* spp. undergrowths, are encountered.

Figure 20.—*Abies concolor/Arctostaphylos uva-ursi* habitat type, San Juan Mountains. In this plot, *A. uva-ursi* cover is 15% and *Festuca arizonica* cover is 2%.

Comments.—This relatively minor type is perhaps best suited for wildlife use. Timber productivity is low, and xeric conditions of most stands may hinder regeneration following logging. Because of low snow accumulations, forests in this habitat type often provide winter range for wildlife.

Pfister et al. (1977) reported a *Pseudotsuga menziesii/Arctostaphylos uva-ursi* habitat type in Montana that is weakly similar to the type described here.

Abies concolor/Festuca arizonica habitat type (ABCO/FEAR; white fir/Arizona fescue)

This relatively minor type primarily occurs in the Jemez and San Juan Mountains of New Mexico.

Vegetation.—*Abies concolor* and *Pseudotsuga menziesii* codominate. *Pinus ponderosa* is an important seral or minor climax species. *Danthonia parryi*, *Festuca arizonica*, *Muhlenbergia montana*, and *Poa fendleriana* attest to the grassy character of the undergrowth (fig. 21). Shrub and forb cover is generally minor.

Physical setting.—This type occurs on all aspects and slope positions within the elevational range of 8,200 to 10,200 feet (2,500 to 3,110 m). Slopes are moderate to steep. Climates are seasonally dry and are near the warm limits of mixed conifer forests (Moir and Ludwig 1979). Soils include Argiborolls and Dystrochrepts.

Adjacent habitat types.—In warmer situations, the ABCO/FEAR HT adjoins the PSME/FEAR or PIPO/ FEAR HT's, while cooler situations favor *Picea pungens* dominance.

Comments.—As with other grass-dominated habitat types, grazing by both domestic stock and elk will be an important management consideration. Historically, fires were common within this type and served as a thinning agent to maintain open stands (Moir and Ludwig 1979). Growth of grasses in the undergrowth is best expressed in openings and, thus, a fire management program would enhance grazing opportunities. Caution is necesary in

utilizing prescribed fire, however, because years of fire suppression have favored heavy fuel accumulations and dense stands of young trees, conditions that are conducive to highly destructive fires (Biswell et al. 1973).

Timber management probably favors either *Pseudotsuga menziesii* or *Pinus ponderosa*, or a combination of the two. However, *P. ponderosa* is near its mesic limits in this type and its regeneration may be difficult because of competition from *Abies* and *Pseudotsuga* (Moir and Ludwig 1979).

This type has been reported previously in Arizona and New Mexico (Fitzhugh et al.,[9] Moir and Ludwig 1979).

Abies concolor/Quercus gambelii habitat type (ABCO/QUGA; white fir/Gambel oak)

This type, which occurs throughout the southern Rocky Mountains, is the most widespread mixed conifer habitat type within the study area.

Vegetation.—*Abies concolor* and *Pseudotsuga menziesii* codominate the overstory. *Pinus flexilis*, *Pinus ponderosa*, and *Populus tremuloides* are common seral species. *Quercus gambelii* is the most characteristic undergrowth species, often forming nearly impenetrable thickets (fig. 22). *Mahonia repens*, *Rosa* spp., and *Symphoricarpos oreophilus* are often important shrubs. *Jamesia americana* is an important shrub on moist sites in this type. Other than *Carex rossii*, graminoid cover is scant, although *Bromopsis ciliata* and *Poa fendleriana* are fairly constant. Forb species diversity is often high, but total cover is generally less than 10%.

Figure 21.—*Abies concolor/Festuca arizonica* habitat type, San Juan Mountains. Common species in this plot are *F. arizonica*, *Muhlenbergia montana*, and *Arctostaphylos uva-ursi*.

Figure 22.—*Abies concolor/Quercus gambelii* habitat type, San Juan Mountains. *Q. gambelii* is diagnostic in the undergrowth.

Physical setting.—The type occurs on all landscape positions and aspects at elevations from 7,900 to 9,500 feet (2,410 to 2,900 m). Slopes vary from gentle to very steep. Soils are often in lithic subgroups.

Adjacent habitat types.—The ABCO/QUGA HT often adjoins *Pseudotsuga menziesii* or *Pinus ponderosa* forests lacking an *Abies* component. Wetter or cooler sites merge to the ABCO/ACGL HT, while drier or warmer sites have grassy undergrowths, similar to the ABCO/FEAR HT.

Comments.—This type has been previously described in Arizona and New Mexico (Alexander et al. 1984, Fitzhugh et al.,[9] Moir and Ludwig 1979). Fire is a major ecological component of these forests, and the high *Quercus* cover may relate to its ability to reproduce vegetatively after fire. Timber productivity is moderate. The type provides valuable cover and browse for deer populations.

Pinus flexilis Series

Pinus flexilis/Arctostaphylos uva-ursi habitat type (PIFL/ARUV; limber pine/kinnikinnik)

The PIFL/ARUV HT is minor in occurrence and is the only habitat type in the *Pinus flexilis* series. The few samples were taken in the northern portion of the Sangre de Cristo Mountains in New Mexico and in the Wet Mountains of Colorado.

Vegetation.— *Pinus flexilis* dominates, or is codominant with *Pseudotsuga menziesii* in the overstory; *Picea engelmannii* is often subdominant (fig. 23). The undergrowth is characterized by a conspicuous *Arctostaphylos uva-ursi* layer and the common occurrence of *Juniperus communis*. Herbaceous cover seldom exceeds trace amounts.

Physical setting.—Elevations cluster around 9,850 feet (3,000 m) and landforms are steep southerly-facing upper slopes. Soils typically are skeletal and are Dystric Cryochrepts or Typic Cryorthents.

Adjacent habitat types.—Most commonly, the PIFL/ARUV HT borders the ABLA/VAMY HT that is found on less exposed and cooler environments within the same elevational zone. Transitions to the ABCO/Sparse HT also are to be expected.

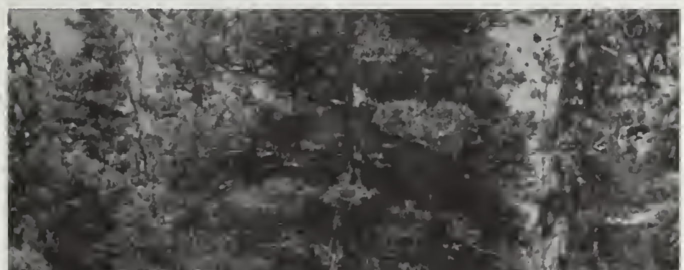

Figure 23.—*Pinus flexilis/Arctostaphylos uva-ursi* habitat type, Sangre de Cristo Mountains. *A. uva-ursi* is conspicuous in the undergrowth.

Comments.—The relatively warm winter climate and presence of big game forage species in this type make it an important winter range. The large seeds of *Pinus flexilis* provide food for birds and small mammals. Livestock use is very light because of difficult accessibility and low graminoid production.

The PIFL/ARUV HT represents drier sites within the *Abies lasiocarpa/Vaccinium* spp. zone. The exposed conditions favor snow movement rather than accumulation, and the well-drained, skeletal soils store inadequate water to support *Abies lasiocarpa* forest. Thus, the stands remain open, favoring the growth of heliophytic *Arctostaphylos uva-ursi*.

Timber productivity is low. Management would typically favor *Pseudotsuga menziesii* because *Pinus flexilis* is generally not an economically important species. High surface soil temperatures combined with low soil moisture may hamper regeneration following logging (Pfister et al. 1977).

Highly similar types have been described elsewhere. These include the *Pseudotsuga menziesii/Arctostaphylos uva-ursi* habitat type in southern New Mexico (Fitzhugh et al.[9]), the xeric *Pinus contorta-Pseudotsuga* forest communities in northern Colorado (Peet 1981), and the *Pseudotsuga menziesii/Arctostaphylos uva-ursi* habitat type in Montana (Pfister et al. 1977). Very close affinities are shared with the *Pseudotsuga menziesii*, *Arctostaphylos uva-ursi*, *Juniperus communis* habitat types in south-central Colorado (Shepherd[6]), and the *Pinus flexilis/Juniperus communis* habitat type in northern Colorado, central Idaho, and Montana (Hoffman and Alexander 1980, Pfister et al. 1977, Steele et al. 1981).

Pseudotsuga menziesii Series

The *Pseudotsuga menziesii* series is relatively minor in the study area and is represented by only two habitat types: PSME/FEAR and PSME/QUGA.

Vegetation.—In addition to *Pseudotsuga menziesii*, *Pinus ponderosa* often dominates the overstory. Warmer sites within the series may also support *Juniperus scopulorum* and *Pinus edulis*. *Abies concolor* is absent or minor. Early successional forests are typically dominated by either *Populus tremuloides*, in the PSME/FEAR HT, or *Quercus gambelii*, in the PSME/QUGA HT.

The undergrowth varies from grassy *Festuca arizonica* to nongrassy, *Quercus gambelii* dominated situations.

Physical setting.—Steep slopes characterize this series. Elevations range from 6,550 to 9,500 feet (2,000 to 2,900 m). Soils generally have udic moisture regimes at higher elevations and ustic moisture regimes at lower elevations. Temperature regimes are frigid.

Adjacent habitat types.—Warm, dry sites favor habitat types of the *Pinus ponderosa* series, while ecotones in moist environments are with *Abies concolor* habitat types.

Comments.—*Pseudotsuga menziesii* has the greatest ecological amplitude of any coniferous species in the study area. In the northern Rocky Mountains, Rehfeldt (1974) demonstrated substantial genetic variation among *P. menziesii* populations from contrasting habitats. This

genetic diversity contributes to the broad ecological amplitude. However, *P. menziesii* is less shade-tolerant than *Abies* spp. and is not considered climax in stands with *Abies* spp. Thus, the *P. menziesii* series is relatively minor in areal extent since most stands where it is important are codominated by more shade-tolerant species. North of the study area, in central and northern Colorado, *Abies concolor* does not occur; thus, some habitat types listed here within the *Abies concolor* series may appear as *P. menziesii* climax types in other locations.

The series generally does not contain productive timberlands. Management would typically favor *Pseudotsuga menziesii*. Forage production for livestock is high in the *Festuca arizonica* dominated forests.

Pseudotsuga menziesii/Festuca arizonica habitat type (PSME/FEAR; Douglas-fir/Arizona fescue)

This is a minor type found in the mountain ranges of southern Colorado and the northern Sangre de Cristo Mountains in New Mexico.

Vegetation.—With the exception of *Abies concolor*, all coniferous species of mixed conifer forests may be expected within this type. *Festuca arizonica* dominance is diagnostic within the highly varied undergrowth (fig. 24). *Koeleria macrantha* is always present and *Muhlenbergia montana*, with up to 15% cover, often occurs as well. *Arctostaphylos uva-ursi* and *Poa fendleriana* are sometimes well represented.

Physical setting.—This habitat type occurs most frequently on steeply sloping southerly exposures from 8,850 to 9,500 feet (2,700 to 2,900 m) elevation. Surface rock cover in excess of 15% is common. Soils include Borolls, Boralfs, and Orthents.

Adjacent habitat types.—Close similarities occur between the PSME/FEAR HT and the ABCO/FEAR HT. The main diagnostic feature of the PSME/FEAR is the absence of *Abies concolor*, suggesting warmer and drier conditions. The PSME/QUGA HT occurs in rockier situations. The PSME/FEAR HT often adjoins meadows.

Figure 24.—*Pseudotsuga menziesii/Festuca arizonica* habitat type, San Juan Mountains. The undergrowth in this open-forest plot is dominated by *F. arizonica* and *Muhlenbergia montana*.

Figure 25.—*Pseudotsuga menziesii/Quercus gambelii* habitat type, *Quercus gambelii* phase, San Juan Mountains. The combined cover of the shrubs *Amelanchier alnifolia, Q. gambelii, Rosa woodsii*, and *Symphoricarpos oreophilus* equals 60% in this plot.

Comments.—As with other *Festuca*-dominated types, grazing is a prime management consideration. Deer, elk, and bighorn sheep find winter cover and forage in this type.

Timber productivity is low. *Pseudotsuga menziesii* and *Pinus ponderosa* are commercial species, but grass competition hinders regeneration following logging.

The type has been recognized in Arizona and New Mexico by Moir and Ludwig (1979) and Fitzhugh et al.[9] In Colorado, Shepherd[6] described a complex of eight *Pseudotsuga menziesii* habitat types having grassy undergrowths dominated by *Festuca arizonica* that are identifiable with the PSME/FEAR HT. Similarities occur with the *Pseudotsuga menziesii/Festuca idahoensis* habitat type described in the northern Rockies (Pfister et al. 1977, Steele et al. 1981).

Pseudotsuga menziesii/Quercus gambelii habitat type (PSME/QUGA; Douglas-fir/Gambel oak)

This type occurs throughout the study area.

Vegetation.—In addition to *Pseudotsuga menziesii*, *Pinus ponderosa* is often a dominant in the overstory.

Undergrowths vary from nongrassy *Quercus gambelii* dominated (fig. 25) to relatively grassy *Quercus gambelii*-*Festuca arizonica* associations. *Amelanchier alnifolia*, *Symphoricarpos oreophilus*, *Carex geyeri*, and *Muhlenbergia montana* are sometimes important.

Two phases are recognized: (1) the *Festuca arizonica* (FEAR) phase, with *Festuca arizonica* present and grass species more evident in the undergrowth; and (2) the *Quercus gambelii* (QUGA) phase, with *Festuca arizonica* absent and shrub species dominant.

Physical setting.—Slopes range from moderate to very steep; elevations vary from 6,550 to 9,200 feet (2,000 to 2,800 m), with stands occurring on all aspects. Soils are predominately Eutroboralfs, Glossoboralfs, and Argiborolls.

Adjacent habitat types.—This type occupies a position in the environmental gradient between the ABCO/QUGA

and the PIPO/QUGA HT's. The three habitat types constitute the most widespread forests in the study area.

Comments.—As in the other habitat types where *Quercus gambelii* is diagonostic, oak is the most conspicuous feature of the vegetation. Grasses are commonly important in the undergrowth, especially in the FEAR phase. This habitat type has broad possibilities for management, ranging from forage utilization to timber production, which is low to moderate. Multilayered canopies in the undergrowth in this shrubby type support varied bird species (Fitzhugh et al.[9]).

This PSME/QUGA HT has been reported in Arizona and New Mexico (Alexander et al. 1984, Fitzhugh et al.[9]). Hess and Wasser[8] described a highly similar type in central Colorado, the *Pinus ponderosa/Quercus gambellii/Carex geyeri* habitat type. Very weak affinities are shared with mesic foothill woodland communities of northern Colorado (Peet 1981) and the *Pseudotsuga menziesii/Symphoricarpos oreophilus* habitat type from the northern Rockies (Pfister et al. 1977, Steele et al. 1981).

Pinus ponderosa Series

The *Pinus ponderosa* series is found throughout the low-elevation sites of the study area.

Vegetation.—*Pinus ponderosa* is the least shade-tolerant tree of the seven species considered in this study. Therefore, only those stands where *P. ponderosa* dominates the regeneration are considered to lie within the *Pinus ponderosa* series. In moister environments within the *P. ponderosa* series, *Pseudotsuga menziesii* may occur in minor amounts, and in warm-dry situations, *Pinus edulis* and *Juniperus scopulorum* are important. *Quercus gambelii* is a common seral species; however, in areas lacking *Quercus*, succcession to *P. ponderosa* may be direct.

Dry-site undergrowths are similar to adjacent non-forest communities. Grasses such as *Bouteloua gracilis*, *Muhlenbergia montana*, *Poa fendleriana*, and *Schizachyrium scoparium* are characteristic. Moist-site undergrowths are similar to the *Pseudotsuga menziesii* series and also to the drier habitats in the *Abies concolor* series. In these cases, *Arctostaphylos uva-ursi*, *Quercus gambelii*, and *Festuca arizonica* may be important.

Physical setting.—The series may be found on any slope or aspect between elevations of 5,900 to 9,500 feet (1,800 to 2,900 m). Soils are generally frigid and ustic.

Adjacent habitat types.—The first forest type encountered above low-elevation grasslands and pinyon-juniper woodlands is *Pinus ponderosa*. Except for *Pinus edulis* and *Juniperus* spp., *P. ponderosa* is the most drought-resistant conifer in the study area. Following *P. ponderosa* in drought-resistance is *Pseudotsuga menziesii* (Pharis 1966). Higher elevational ecotones are with the *P. menziesii* series. In some mesic situations, ecotones to the *Abies concolor* series occur.

Comments.—Surface fires at intervals of 5 to 12 years are a natural component of the *Pinus ponderosa* cover type and serve to maintain open parklike stands throughout much of the series (Cooper 1960, Weaver 1951). However, the advent of modern fire suppression has resulted in the establishment of dense patches of young trees in many areas. Shade and needle accumulation under such patches hinders development of the herbaceous undergrowth (Daubenmire and Daubenmire 1968). In such situations, habitat type identification may be difficult because of low coverage or absence of indicator species.

Undisturbed forests are rarer in the *Pinus ponderosa* series than in others. Damage from overgrazing has been particularly severe, resulting in localized elimination of species and conversions of grass-rich undergrowths to those rich in weeds. Dominance of such forb species as *Hymenoxys* spp., *Taraxacum officinale*, and *Xanthocephalum sarothrae* indicates overgrazing, as does the abundance of certain indicator grasses—*Bromus tectorum*, *Poa pratensis* and, to some extent, *Poa fendleriana* and *Sitanion hystrix*. Such pervasive alteration of the undergrowth adds to the difficulty in determining the correct habitat type. In some cases, soil disturbance may be so severe that the ability of such sites to support the predisturbance plant association no longer exists.

Similarly, the ease of access in the *Pinus ponderosa* series and the desirable properties of *P. ponderosa* lumber has resulted in heavy timber harvests throughout the series. The alteration of the tree canopy further adds to the difficulty in identifying habitat types in the *P. ponderosa* series.

In general, forests in the *Pinus ponderosa* series are less productive than the more mesic series at higher elevations. Natural regeneration is generally difficult because favorable seedcrops, suitable seedbeds, and soil moisture must be coincidental. Dense grass cover and heavy livestock grazing may impede regeneration. As many *P. ponderosa* habitat types are rich in graminoids, livestock grazing is a prime management direction. Recovery from overgrazing may require decades. Abundant big game browse is found in shrubby habitat types, and more open stands may provide important big game winter range.

Pinus ponderosa/Arctostaphylos uva-ursi habitat type (PIPO/ARUV; ponderosa pine/kinnikinnik)

This is a minor habitat type found in the Jemez and Sangre de Cristo Mountains of New Mexico and the Wet Mountains of Colorado.

Vegetation.—*Pinus ponderosa* dominates the tree layer, with *Pseudotsuga menziesii* having minor importance in some areas. *Abies concolor* is infrequent or absent. *Arctostaphylos uva-ursi* is conspicuous as an undergrowth dominant and is diagnostic of this type. *A. uva-ursi* coverage ranges from 30% to 70% and, generally, it is the sole dominant species (fig. 26). Graminoids that are occasionally important include *Carex heliophila*, *C. rossii*, *Festuca arizonica*, and *Muhlenbergia montana* (up to 5% cover). Shrub cover other than *A. uva-ursi* is generally low; however, *Quercus gambelii* is often present. In the sparse forb layer, few species ever exceed 1% cover; *Lathyrus* spp. is important locally.

Physical setting.—This type is confined primarily to lower slopes and ridges at elevations of 7,700 to 9,200

feet (2,350 to 2,800 m). The type occurs on all exposures and slopes from gentle to very steep. Ridge soils in this type belong to lithic subgroups, while lower slope soils have moderately deep profiles.

Adjacent habitat types.—The PIPO/ARUV HT intergrades with the ABCO/ARUV HT on ridges, the ABCO/QUGA HT on upper north-facing slopes, and the PIPO/QUGA HT on upper south-facing slopes.

On lower slopes, adjoining habitats include such grass dominated types as the PIPO/FEAR HT and in moister situations the PIPU/FEAR HT. When the PIPO/ARUV HT occurs on lower south-facing slopes, it often intergrades to the ABCO/ARUV HT as the exposure shifts northward.

Comments.—The PIPO/ARUV HT has not been described previously. However, it shares many characteristics of the PSME/ARUV HT as defined in the mountains of southwestern New Mexico by Fitzhugh et al.[9] The PIPO/ARUV HT is not widespread in the southern Rockies, because *Arctostaphylos uva-ursi* is generally absent in mountain floras south of the San Juan and Sangre de Cristo Mountains, but is a major element of many mountain floras to the north.

Site quality is poor for timber production. Wildlife use is moderate.

Pinus ponderosa/Festuca arizonica habitat type (PIPO/FEAR; ponderosa pine/Arizona fescue)

This habitat type is widespread within the study area.

Vegetation.—*Pinus ponderosa* is the climax dominant, but *Pseudotsuga menziesii* is minor in some stands. Dominance by grasses and, sometimes, forbs is diagnostic of this type, with shrubs distinctly of secondary importance (fig. 27). *Quercus gambelii* never exceeded 5% cover in sampled stands. *Koeleria macrantha, Poa fendleriana,* and *Sitanion hystrix* frequently are important grasses. *Achillea millefolium* ssp. *lanulosa, Antennaria rosea, Erigeron formosissimus* and *Potentilla hippiana* are locally abundant forbs.

Figure 26.—A *Pinus ponderosa/Arctostaphylos uva-ursi* habitat type, Wet Mountains at 9,000 feet (2,740 m). This plot is an open stand with undergrowth dominated by *A. uva-ursi*.

Figure 27.—*Pinus ponderosa/Festuca arizonica* habitat type, *Danthonia parryi* phase, San Juan Mountains. *D. parryi, F. arizonica*, and *Muhlenbergia montana* are all well represented in this plot.

The PIPO/FEAR HT has been divided into three phases: (1) *Danthonia parryi* (DAPA) phase, with *Danthonia parryi* present and other graminoids usually conspicuous; (2) *Festuca arizonica* (FEAR) phase, with *Danthonia parryi* scarce or absent and *Festuca arizonica* conspicuous; and (3) *Bouteloua gracilis* (BOGR) phase, with *Danthonia parryi* absent and *Bouteloua gracilis* present.

Pinus ponderosa is the climax dominant tree throughout the type, with *Festuca arizonica* and *Muhlenbergia montana* consistently important undergrowth grasses. *Danthonia parryi* has up to 60% cover in plots where it delineates a phase. The *Bouteloua gracilis* phase represents the hot, dry extreme of the type and features *Pinus edulis* and *Juniperus* spp. in the overstory.

Physical setting.—The type occurs on all aspects and landscape positions from lower slopes to ridges within an elevational range of 7,200 to 9,500 feet (2,190 to 2,900 m). Slopes vary from gentle to very steep. Soils are predominantly Borolls, but Boralfs and, to a lesser degree, Orthents and Ochrepts are also represented. Generally, the soils are low in coarse fragments.

Adjacent habitat types.—The PIPO/FEAR HT adjoins the PIPO/QUGA HT, FEAR phase, as soils become rockier. Where conditions become more mesic, this type

is adjacent to forests dominated by the ABCO/FEAR HT. Drier sites support less *Festuca arizonica*, with *Bouteloua gracilis* increasing in importance.

Comments.—This habitat type is the coolest and wettest of the grassy *Pinus ponderosa* habitat types. Also, soils are typically deeper in this habitat type than in other related *Pinus* types. Heavy grass cover favors surface fires; the absence of fire would tend to result in denser tree canopy cover and subsequently reduced grass cover.

Muhlenbergia montana is often a codominant grass, especially in the FEAR phase. However, it has wide ecological amplitude, being important in many contrasting habitat types and, thus, has low indicator value. *Festuca arizonica* has a relatively narrow ecological amplitude and is a highly diagnostic species.

High grass cover makes this habitat type particularly desirable for livestock or big game range. However, overgrazing has been widespread and has reduced or, in some cases, eliminated *Festuca arizonica*. The occurrence of weedy species, such as *Bromus tectorum*, *Hymenoxys acaulis*, *H. richardsonii*, *Poa pratensis*, *Taraxacum officinale*, and *Xanthocephalum sarothrae* indicates overgrazing. At the mesic end of *Pinus ponderosa* distribution, many disturbed sites with deep loamy soils that currently lack *F. arizonica*, but are covered with the above species, probably are within the PIPO/FEAR HT. Since *Danthonia parryi* is highly palatable to livestock, the area identifiable as this phase may have been greater in the past.

The DAPA phase has not been described elsewhere; however, environmental conditions align closely with the *Festuca scabrella* phase of the *Pinus ponderosa/Festuca idahoensis* habitat type described in Montana by Pfister et al. (1977). High *Danthonia parryi* cover and relatively cool sites with deep soils characterize the phase. Site quality for tree growth within the DAPA phase is moderate. This phase is not widespread and is relatively unimportant for timber production.

The FEAR phase of this type has been described in the Mogollon Mountains (Fitzhugh et al.[9]) and is comparable to the *Pinus ponderosa/Festuca arizonica* habitat type in northern Arizona (Hanks et al. 1983). Similar stands identified as the *Pinus ponderosa/Festuca idahoensis* habitat type are recognized in the central and northern Rockies (Daubenmire and Daubenmire 1968, Hoffman and Alexander 1976, Pfister et al. 1977, Steele et al. 1981). The FEAR phase has low timber productivity.

The BOGR phase has been described in northern Arizona by Hanks et al. (1983) and in southwestern New Mexico and southeastern Arizona by Fitzhugh et al.[9] Site quality for timber production is low.

Pinus ponderosa/Quercus gambelii habitat type (PIPO/QUGA; ponderosa pine/Gambel oak)

This habitat type is found throughout the study area.

Vegetation.—*Pinus ponderosa* is the major climax dominant tree within this habitat type. *Pinus edulis* and *Juniperus scopulorum* are typically absent. *Quercus*

Figure 28.—*Pinus ponderosa/Quercus gambelii* habitat type, *Quercus gambelii* phase, Spanish Peaks. The undergrowth is dominated by *Q. gambelii* (35% cover).

gambelii trees and shrubs typify the undergrowths, sometimes forming impenetrable thickets (fig. 28). *Cercocarpus montanus* is another characteristic shrub. Graminoids occurring across this habitat type include *Bouteloua gracilis*, *Carex heliophila*, *C. rossii*, *Koeleria macrantha*, *Muhlenbergia montana*, *Poa fendleriana*, and *Sitanion hystrix*. *Achillea millefolium* ssp. *lanulosa* and *Artemisia ludoviciana* are the most characteristic forbs.

Three phases are recognized: (1) *Festuca arizonica* (FEAR) phase, with *Festuca arizonica* present; (2) *Quercus gambelii* (QUGA) phase, with *Pinus edulis* and *Festuca arizonica* scarce or absent; and (3) *Pinus edulis* (PIED) phase, with *Pinus edulis* common as advanced regeneration.

The FEAR phase generally exhibits codominance of both *Festuca arizonica* and *Muhlenbergia montana* in the undergrowth. In the QUGA phase, few undergrowth species with high cover occur consistently. Individual forb species in this phase seldom exceed 1% cover, but *Poa fendleriana* cover averages 5% and is often diagnostic.

Physical setting.—This type encompasses considerable topographic variation. Elevations range from 6,550 to 9,200 feet (2,000 to 2,800 m). Slopes vary from gentle to very steep, and soils from shallow to deep. Typical soil subgroups include Mollic Eutroboralfs, and Typic and Lithic Arigiborolls or Eutroboralfs.

Adjacent habitat types.—As sites become wetter and/or cooler, this type intergrades to the ABCO/QUGA or PSME/QUGA HT's. In contrast, warmer and drier sites have a pinyon-juniper woodland cover. Mosaics of the PIPO/QUGA HT and grassy *Pinus ponderosa* habitat types often form on given slopes in response to microsite variations. *Quercus gambelii* typically dominates rocky sites, while grasses dominate sites with deeper soils; this is consistent with Peet's (1981) observations.

Comments.—Of 165 plots sampled in the *Pinus ponderosa* series, 61 are classified as the PIPO/QUGA HT, attesting to the widespread importance of this type in the southern Rocky Mountains.

As with all habitat types in the *Pinus ponderosa* series, fire is an important ecological factor in succession. In the PIPO/QUGA HT following a catastrophic fire, Quer-

cus gambelii soon forms dense thickets by extensive root sprouting. Competition with conifer regeneration is severe during this persistent Q. gambelii stage of succession (Hanks 1966). Certain areas where Q. gambelii alone dominates stands, with no hint of conifer establishment, may in fact represent a Q. gambelii climax series (Brown 1958).

Although livestock grazing is common in this type, dense oak thickets and a general lack of surface water are a hindrance to management in many areas; also, forage production is low. However, *Quercus gambelii* and *Cercocarpus montanus* are favorable browse species and receive moderate to heavy use by deer and elk. Big game cover often is very good; some areas may be used as winter range.

Release of *Quercus gambelii* following logging or fire results in situations that hinder regeneration of *Pinus ponderosa*. Timber productivity is generally low.

The QUGA phase of this habitat type has previously been described for southern New Mexico and southeastern Arizona (Alexander et al. 1984, Fitzhugh et al.[9]). In northern Arizona, a related *Pinus ponderosa/Festuca arizonica* habitat type, *Quercus gambelii* phase, has been described (Hanks et al. 1983). The habitat type of Hanks et al. (1983) is very similar to the FEAR phase described here, except for a shift in the balance between Q. *gambelii* and F. *arizonica* cover. Hess and Wasser[8] described a related *Pinus ponderosa/Quercus gambelii/Carex geyeri* habitat type in central Colorado. Steele et al. (1981) found a weakly related *Pinus ponderosa/Symphoricapos oreophilus* habitat type in central Idaho. Close affinities occur between the PIPO/QUGA HT, PIED phase, and that portion of the *Pinus ponderosa/Quercus gambelii* habitat type described in New Mexico and Arizona by Alexander et al. (1984) and Fitzhugh et al.[9] that has a high representation of *Pinus edulis*. Similarly, Hanks et al. (1983) described a *Pinus ponderosa/Bouteloua gracilis* habitat type, *Quercus gambelii* phase, that is comparable to the PIED phase described here.

Pinus ponderosa/Muhlenbergia montana habitat type (PIPO/MUMO; ponderosa pine/mountain muhly)

This habitat type is located mostly in the San Juan Mountains of New Mexico. Occasional examples of the type also occur in the Sangre de Cristo Mountains.

Vegetation.—*Pinus ponderosa* is the only tree consistently dominant in this habitat type. *Juniperus* spp. or *Pinus edulis* may occur as occasional trees. Grass species other than *Koeleria macrantha, Muhlenbergia montana, Poa fendleriana,* and *Sitanion hystrix* are of low frequency (fig. 29). In the absence of other indicator species, the highly constant *M. montana* is considered diagnostic. *Quercus gambelii* exhibits up to 5% cover in this habitat type. Characteristic forbs include *Arenaria fendleri, Erigeron flagellaris,* and *E. formosissimus.* Total forb cover is relatively low, although a moderately high number of species may occur on a given site.

Physical setting.—This habitat type characteristically is found on gently sloping ridges, mesa tops, and benches between the elevations of 7,550 and 8,500 feet (2,300 and 2,590 m). The soil surface is covered with litter, with little rock and bare soil. Soils are shallow to deep and have loamy to clayey textures with low to high coarse fragment content. Typical soil great groups include Ustorthents, Ustochrepts, and Eutroboralfs.

Figure 29.—*Pinus ponderosa/Muhlenbergia montana* habitat type, San Juan Mountains. In this plot, undergrowth is rich in *Koeleria macrantha, M. montana, Poa fendleriana,* and *Sitanion hystrix.*

Adjacent habitat types.—The PIPO/MUMO HT often forms a mosaic with the PIPO/QUGA HT. As site conditions become mesic, the type has ecotones with the PIPO/FEAR HT. On more xeric sites, this habitat type intergrades to the PIPO/BOGR HT.

Comments.—This habitat type has previously been described in the Mogollon Mountains of southwestern New Mexico by Fitzhugh et al.[9] Further, Peet (1981) identified xeric foothill and montane woodland communities in northern Colorado that are closely similar to the type.

Because the PIPO/MUMO HT generally occurs on gentle topography and has good forage production potential, heavy grazing has been widespread. In some areas, it is difficult to determine if the absence or low cover of such indicator species as *Festuca arizonica* or *Schizachyrium scoparium* is an artifact of disturbance that affects *Muhlenbergia montana* to a lesser extent. Timber productivity is low in this type.

Pinus ponderosa/Bouteloua gracilis habitat type (PIPO/BOGR; ponderosa pine/blue grama)

This habitat type occurs in the San Juan and Sangre de Cristo Mountains of New Mexico.

Vegetation.—Generally, *Pinus ponderosa* and *P. edulis* codominate the tree stratum. *Juniperus monosperma* and *J. scopulorum* are frequently important. *Quercus gambelii* is generally present but poorly represented; total shrub cover seldom exceeds 1%. *Bouteloua gracilis* or *Schizachyrium scoparium* is diagnostic of the type and sometimes shares high coverage with other grasses such as *Blepharoneuron tricholepis, Bouteloua curtipendula, Muhlenbergia montana, Poa fendleriana,* and *Sitanion hystrix* (fig. 30). *Lotus wrightii* is an important undergrowth forb on some sites.

Two phases of this habitat type are recognized: (1) *Schizachyrium scoparium* (SCSC) phase, with *Schizachyrium scoparium* well represented; and (2) *Bouteloua gracilis* phase, with *Schizachyrium scoparium* poorly represented or absent.

The SCSC phase is weakly similar to the *Pinus ponderosa/Andropogon* habitat type described in Montana by Pfister et al. (1977). The phase is most extensive on the eastern slope of the Sangre de Cristo Mountains in New Mexico, where elements of the Great Plains, such as *Schizachyrium scoparium*, are common. *S. scoparium* is highly palatable and susceptible to damage from excess grazing pressure.

The BOGR phase has been described in northern Arizona by Hanks et al. (1983) and in southwestern New Mexico and southeastern Arizona by Fitzhugh et al.[9] This phase and the SCSC phase represent sites at or near the hot-dry extremes of *Pinus ponderosa* growth.

Physical setting.—The type occurs on all aspects, from gentle to steep lower slopes to mesa tops and benches. Elevations range from 6,250 to 8,550 feet (1,900 to 2,610 m). Soils vary from sandy to clayey textures and from low to high coarse fragment content. Taxonomically, soils in this type are quite variable.

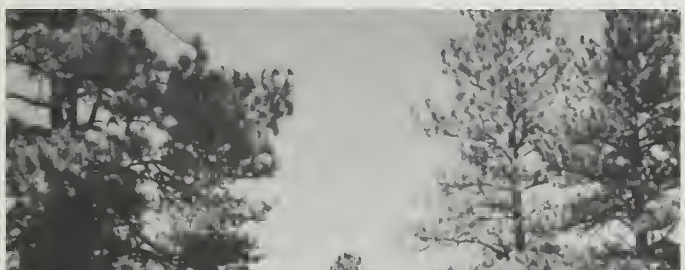

Figure 30.—A *Pinus ponderosa/Bouteloua gracilis* habitat type, *Schizachyrium scoparium* phase, Sangre de Cristo Range at 7,300 feet (2,220 m). *B. curtipendula*, *B. gracilis*, and *S. scoparium* are common in the undergrowth.

Figure 31.—*Pinus ponderosa/Quercus undulata* habitat type, Sangre de Cristo Mountains. In addition to *Q. undulata*, *Pinus edulis* and *Juniperus scopulorum* are important in this plot.

Adjacent habitat types.—On rocky slopes, the PIPO/BOGR HT merges with the PIPO/QUGA or PIPO/QUUN HT's. Pinyon-juniper woodland forms the lower ecotone with this habitat type. The type occurs near the xeric limit of *Pinus ponderosa* growth.

Comments.—This moderately extensive habitat type characteristically supports open stands bordering on pinyon-juniper woodlands or sagebrush meadows. The high cover of grasses makes the habitat type valuable for grazing by domestic stock and wildlife. Site quality for *Pinus ponderosa* is generally low. Hanks et al. (1983) suggest that *Bouteloua gracilis* often gains dominance in xeric *Festuca arizonica* habitats that have been overgrazed. Therefore, care must be taken in identifying habitat types in dry, grassy *Pinus ponderosa* communities.

Pinus ponderosa/Quercus undulata habitat type (PIPO/QUUN; ponderosa pine/wavyleaf oak)

This type is most common in northern New Mexico on the eastern foothills of the Sangre de Cristo Mountains, and is rare in Colorado and in the San Juan Mountains of New Mexico.

Vegetation.—*Pinus ponderosa* is the indicated climax in this habitat type, with *P. edulis* and *Juniperus scopulorum* frequently codominants. Undergrowths are characterized by an assortment of warm-dry indicators (fig. 31). *Quercus undulata*, the dominant shrub, exhibits up to 65% cover, but *Yucca* also is usually present. Other than *Artemisia ludoviciana*, forb cover is generally less than 1%, but various species of *Echinocereus* and *Opuntia* generally are found in the undergrowth. *Bouteloua gracilis*, *Muhlenbergia montana*, and *Schizachyrium scoparium* are dominant grasses and *Andropogon gerardi* is typically present.

Physical setting.—This habitat type occurs on mesa tops with lithic, sandy to loamy soils, and on canyon slopes with typically shallow coarse to fine textured soils. Elevations range from 6,550 to 8,200 feet (2,000 to 2,500 m). The type occurs on all aspects; surface rock cover is generally high, averaging 27%.

Adjacent habitat types.—The PIPO/QUUN HT has close similarity to two New Mexico habitat types: *Pinus ponderosa/Quercus grisea* defined in the Mogollon Mountains (Fitzhugh et al.[9]) and *Pinus ponderosa/Quercus undulata* of the Sacramento Mountains (Alexander et al. 1984). In northern New Mexico, the PIPO/QUUN HT shares close affinities with the PIPO/QUGA HT and intergrades at the hot, dry limits of the latter; both habitat types are characterized by a rich complement of grasses. On a single 4,037 square foot (375 m^2) plot, for example, 10 to 15 grasses may be encountered. On hotter and drier sites, this habitat type adjoins pinyon-juniper woodlands.

Comments.—*Quercus undulata* occupies sites at the hot and dry limits of *Q. gambelii*. Individuals with coriaceous leaves lacking distinct lobes were considered *Q. undulata*, while thin, lobed leaved individuals were classed as *Q. gambelii*. The two sites in which these oak variants occur seem to be intrinsically different and worthy of distinction into separate habitat types. Of those sites where *Quercus* is important, the PIPO/QUUN HT represents the hot, dry extreme.

Because of the environmental rigors of this habitat type, site potential for timber production is very low. Livestock grazing in this habitat type is faced with the same difficulties as discussed in the PIPO/QUGA HT, that is, general unavailability of surface water, impenetrable oak thickets, and typically low forage production.

Pinus ponderosa/Artemisia arbuscula habitat type (PIPO/ARAR; ponderosa pine/dwarf sage)

This minor habitat type is found in the vicinity of Petaca Peak in the San Juan Mountains of New Mexico.

Vegetation.— *Pinus ponderosa* is widely scattered among *P. edulis* and *Juniperus scopulorum*. Regeneration of *P. ponderosa* is light but sufficient to maintain climax populations. *P. edulis* and *J. scopulorum* regeneration is often dense. The shrub layer is dominated by *Artemisia arbuscula* ssp. *nova*, with lesser coverage of *Cercocarpus montanus Quercus gambelii*, *Ribes cereum*, *Symphoricarpos oreophilus*, and *Yucca glauca* (fig. 32).

Characteristic graminoids include *Carex heliophila*, *Koeleria macrantha*, *Muhlenbergia montana*, and *Sitanion hystrix*. Total herb cover is typically far less than shrub cover.

Physical setting.—This habitat type occurs on flat basalt mesa tops at elevations around 8,200 feet (2,500 m). Soils are mostly Typic Argiborolls with inclusions of Typic Eutroboralfs.

Adjacent habitat types.—On slightly drier sites the PIPO/ARAR HT adjoins pinyon-juniper woodlands, while slightly moister sites support the PIPO/QUGA HT, PIED phase.

Comments.—This minor type is of interest because of the Great Basin elements of its flora. Grazing capacity is minor and fuelwood opportunities are limited by difficult access.

This habitat type has not been previously described.

Figure 32.—*Pinus ponderosa/Artemisia arbuscula* habitat type, San Juan Mountains. Note the conspicuous ground layer of *A. arbuscula* ssp. *nova* and the strong dominance of *Pinus edulis* and *Juniperus scopulorum*.

Pinus ponderosa/Orysopsis hymenoides habitat type (PIPO/ORHY; ponderosa pine/indian ricegrass)

This minor type occurs on stabilized sand dunes in the vicinity of Espanola, N. Mex., and on the eastern edge of the Great Sand Dunes in Colorado.

Vegetation.—*Pinus ponderosa* and *Juniperus monosperma* typify the very open stands. Undergrowth species occurring in this type are characteristic of the warmest and driest of forested habitats. They include a shrub, *Poliomintha incana*, and two grasses—*Oryzopsis hymenoides* and *Shizachyrium scoparium*.

Physical setting.—The one plot sampled was at 5,900 feet (1,800 m) elevation on a dry, westerly exposure of a stabilized dune.

Adjacent habitat types.—Where vegetation has not yet gained a foothold the type forms ecotones with active sand dunes, while less sandy environments support *Pinus ponderosa/Quercus undulata* associations or pinyon-juniper woodlands.

Comments.—This type is of little consequence for management because of its rare occurrence. Berry (1963) described similar *Pinus ponderosa* forests occupying sandy soils at the forest-steppe ecotone in central Oregon.

OTHER HABITAT TYPES

Scree Forests

Scree habitat types occur throughout the study area.

Vegetation.—Scree habitat types occur in the *Pinus aristata*, *Picea engelmannii*, *Abies lasiocarpa*, *Abies concolor*, *Pseudotsuga menziesii*, and *Pinus ponderosa* series. *Pinus flexilis* is often important in the ABCO/HODU and PSME/HODU HT's. The undergrowth is sparse and species of high constancy generally do not occur in scree habitat types (fig. 33). Typically, shrubs are the dominant undergrowth vegetation.

Scree habitat types and their identifying characteristics are as follows:

1. The *Pinus aristata/Ribes montigenum* habitat type (PIAR/RIMO HT) is characterized by *Ribes montigenum* and *Saxifraga bronchialis*.
2. *Juniperus communis* and *Saxifraga bronchialis* are diagnostic in the *Picea engelmannii/Saxifraga bronchialis* habitat type (PIEN/SABR HT) and the *Abies lasiocarpa/Saxifraga bronchialis* habitat type (ABLA/SABR HT).
3. *Holodiscus dumosus*, *Jamesia americana*, and *Ribes* spp. are often important in the *Abies concolor/Holodiscus dumosus* habitat type (ABCO/HODU HT) and the *Pseudotsuga menziesii/Holodiscus dumosus* habitat type (PSME/HODU HT).
4. In the *Pinus ponderosa/Ribes inerme* habitat type (PIPO/RIIN HT), *Quercus gambelii* and *Ribes* spp. characterize the undergrowth.

Physical setting.—All scree habitat types are found on steep slopes of any exposure. Elevations range from 8,050 feet (2,450 m) in the PIPO/RIIN HT to 11,800 feet (3,600 m) in the PIEN/SABR HT. Mineral soil is confined to pockets between coarse rock fragments that typically compose greater than 80% of the substrate. Vegetation reaches a quasi-equilibrium with the shifting substrate (Pfister et al. 1977).

Adjacent habitat types.—Since scree may occur across the entire elevational gradient in any mountainous area with unstable substrate, any habitat type may adjoin scree.

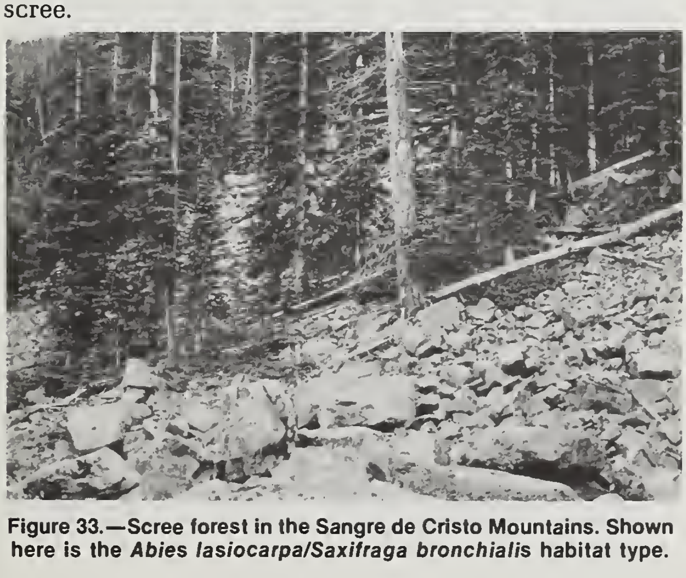

Figure 33.—Scree forest in the Sangre de Cristo Mountains. Shown here is the *Abies lasiocarpa/Saxifraga bronchialis* habitat type.

Comments.—Scree habitat types are more widespread than the small sample size of 19 plots suggests. Forest management opportunities are limited on these areas of poor site quality. Scree habitat types are of little value for grazing or timber production. Watershed and wildlife use generally are the only sustained-yield management options available for scree habitat types.

Scree habitat types are recognizable throughout the Rocky Mountain system. In Arizona and New Mexico, Fitzhugh et al.[9] recognized *Abies lasiocarpa/Holodiscus dumosus* (Scree), *Abies concolor/Jamesia americana* (Scree), and *Pseudotsuga menziesii/Holodiscus dumosus* (Scree) habitat types. Shepherd[6] described many stands identifiable as scree habitat types in south-central Colorado. Pfister et al. (1977) described scree forests in Montana but did not recognize habitat types.

Riparian Forests

Everywhere that streams are found within the study area, riparian habitat types are to be expected.

Vegetation.—Four series and five habitat types are recognized in riparian settings in the study area. These habitat types are:

1. The *Picea engelmannii/Heracleum sphondylium* habitat type (PIEN/HESP HT) is characterized by *Lonicera involucrata*, *Bromopsis ciliata*, *Erigeron eximius*, *Geranium richardsonii*, *Heracleum sphondylium*, *Mertensia ciliata*, *Osmorhiza depauperata*, *Thalictrum fendleri*, and *Viola canadensis* in the undergrowth.
2. The *Picea pungens/Swida sericea* habitat type (PIPU/SWSE HT) is characterized by *Swida sericea*, *Galium triflorum*, *Geranium richardsonii*, and *Smilacina stellata* in the undergrowth.
3. The *Picea pungens/Poa pratensis* habitat type (PIPU/POPR HT) consists of diagnostic *Poa pratensis* in the undergrowth.
4. The *Abies concolor/Galium triflorum* habitat type (ABCO/GATR HT) is characterized by *Acer glabrum*, *Prunus virginiana*, *Quercus gambelii*, *Poa pratensis*, *Galium triflorum*, and *Thalictrum fendleri* in the undergrowth.
5. The *Pinus ponderosa/Poa pratensis* habitat type (PIPO/POPR HT) consists of diagnostic *Poa pratensis* in the undergrowth.

Populus angustifolia generally is the dominant broadleaved tree. However, *Acer negundo* is often important in the PIPO/POPR HT while *Alnus tenuifolia* is a dominant in many stands in the other four habitat types. In excess of 50 species of undergrowth plants is not uncommon within a single, 4,037 square foot (375 m^2) plot in this type (fig. 34).

Physical setting.—Riparian habitat types are confined to stream floodplains at elevations ranging from 6,100 feet (1,860 m) in the PIPO/POPR HT to 9,050 feet (2,760 m) in the PIEN/HESP HT. Slopes are gentle to flat. Soils vary from Typic Udifluvents or Cryofluvents to Fluventic Haploborolls.

Adjacent habitat types.—Riparian forests adjoin these other herb-rich habitat types. Depending on elevation,

these habitat-types may include ABCO/ACGL, PIPU/EREX, or ABLA/EREX.

Comments.—Since riparian habitat types occur on heavily utilized streamsides, few representative stands of the potential climax are available for sampling. Overgrazing has been pervasive and many sites have been converted from species-rich to species-poor sites dominated by *Poa pratensis*, an introduced grass capable of withstanding heavy grazing pressure. Because of the rarity of pristine riparian areas (only 23 plots were sampled), very little is known about riparian habitat types, which are widespread. Fluctuations in stream activity alters soil depth, depth to water table, and vegetation composition, thus adding to the difficulty in applying the climax concept to such sites (Steele et al. 1981). Further research may allow delineation of more habitat types within riparian forests.

Grazing potential is often high, not only because of high production of forbs and graminoids, but also because of the gentle topography and readily accessible water. Timber productivity is moderate within riparian habitat types. However, timber harvesting may be constrained by high water tables in some cases.

In the northern Rockies, Pfister et al. (1977) and Steele et al. (1981) recognizd bottomland hardwood forests and floodplain communities, and Daubenmire and Daubenmire (1968) described *Populus trichocarpa* forests that are representative of the riparian forests identified here. Other investigators have recognized streamside habitat types within a *Picea pungens* series (Fitzhugh et al.,[9] Hess and Wasser,[8] Moir and Ludwig 1979), within a *Abies concolor* series (Alexander et al. 1984, Fitzhugh et al.[9]), and within a *Populus angustifolia* series (Fitzhugh et al.[9]).

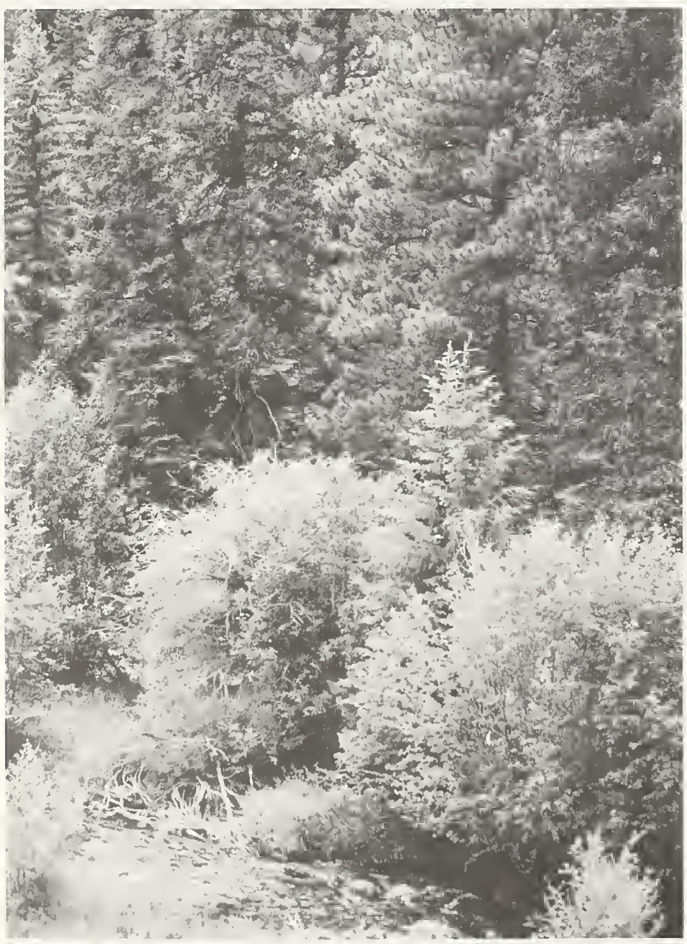

Figure 34.—Riparian forest in the San Juan Mountains. This plot in the *Picea pungens/Swida sericea* habitat type contains 50 vascular plant species in the undergrowth with a total cover in excess of 100%.

SUMMARY

This classification study of forest habitat types in the mountains of northern New Mexico and southern Colorado identified 2 habitat types in the *Pinus aristata* series, 8 habitat types and 2 phases in the *Picea engelmannii* and *Abies lasiocarpa* series, 15 habitat types and 2 phases in the 4 mixed conifer series, and 8 habitat types and 8 phases in the *Pinus ponderosa* series. In addition, 6 forested scree and 5 riparian habitat types were sampled. Thus, a total of 8 climax series, 44 habitat types, and 12 phases of habitat types are defined.

Successional trends varied widely among habitat types. In the *Picea engelmannii* and *Abies lasiocarpa* series, succession to *P. engelmannii* and *A. lasiocarpa* is direct in the highest and coldest elevations, while lower elevations may exhibit any, or a combination, of *Populus tremuloides*, *Abies concolor*, and *Pseudotsuga menziesii* as major seral trees. Succession within the mixed conifer series features *Populus tremuloides*, *Pinus flexilis*, *Pinus ponderosa*, and *Quercus gambelii* as major seral trees. *Q. gambelii* is the principal seral tree of the *Pinus ponderosa* series. More moist habitat types in the *P. ponderosa* series may be regarded as fire climaxes since in the absence of fire the more shade-tolerant, but less fire-resistant *Abies concolor* and *Pseudotsuga menziesii* may eventually dominate.

Close vegetational relationships exist among the many forest habitat types described throughout the Rocky Mountains. The most striking similarities occur within the *Picea engelmannii* and *Abies lasiocarpa* series, while habitat types in the mixed conifer and *Pinus ponderosa* series are of relatively localized occurrence.

Considerable soil variation occurs among the habitat types described. Soil orders sampled in the study included Alfisols, Entisols, Inceptisols, and Mollisols. Soil moisture and soil temperature regimes varied from udic-cryic in the *Picea engelmannii* and *Abies lasiocarpa* series to ustic-frigid in the *Pinus ponderosa* series.

Field identification of habitat types is accomplished through use of a dichotomous key. Ideally, since the classification was developed using mature, minimally disturbed forest, identification of habitat type using the keys and descriptions given is best achieved through examining near-pristine vegetation.

Although this study does not profess to describe all the forest habitat types of northern New Mexico and southern Colorado, it is still quite comprehensive. Furthermore, refinement of the classification should be forthcoming following field evaluation of keys and descriptions.

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APPENDIX 1

Plant List of All Species Identified in Study

Yng regen = trees less than 2 inches (5 cm) d.b.h.
Adv regen = trees 2-10 inches (5-25 cm) d.b.h.
Mature = trees larger than 10 inches (25 cm) d.b.h.

Species	No. of times observed
Trees	
Abies concolor	
Yng regen	185
Adv regen	170
Mature	125
Abies lasiocarpa	
Yng regen	236
Adv regen	223
Mature	169
Acer negundo	
Yng regen	2
Adv regen	2
Mature	2
Juniperus monosperma	
Yng regen	45
Adv regen	19
Mature	4
Juniperus osteosperma (*J. utahensis*)	
Yng regen	2
Adv regen	3
Mature	0
Juniperus scopulorum	
Yng regen	87
Adv regen	61
Mature	18
Picea engelmannii	
Yng regen	250
Adv regen	254
Mature	231
Picea pungens	
Yng regen	87
Adv regen	88
Mature	66
Pinus aristata	
Yng regen	19
Adv regen	18
Mature	16
Pinus contorta	
Yng regen	3
Adv regen	5
Mature	3
Pinus edulis	
Yng regen	105
Adv regen	67
Mature	10
Pinus flexilis	
Yng regen	103
Adv regen	77
Mature	49
Pinus ponderosa	
Yng regen	204
Adv regen	232
Mature	265
Populus angustifolia	
Yng regen	8
Adv regen	8
Mature	14
Populus tremuloides	
Yng regen	113
Adv regen	129
Mature	46
Pseudotsuga menziesii	
Yng regen	270
Adv regen	267
Mature	245
Shrubs	
Acer glabrum	104
Alnus spp.	10
Alnus tenuifolia	8
Amelanchier alnifolia	108
Amelanchier goldmannii	1
Amelanchier utahensis	15
Amorpha canescens	15
Arctostaphylos uva-ursi	95
Artemisia arbuscula ssp. *nova*	6
Artemisia tridentata	8
Berberis fendleri	23
Ceanothus fendleri	40
Cercocarpus montanus	99
Chimaphila umbellata	12
Chrysothamnus spp.	2
Chrysothamnus depressus	6
Chrysothamnus greenei	3
Chrysothamnus nauseosus	27
Chrysothamnus viscidiflorus	3
Clematis columbiana (*C. pseudoalpina*)	115
Clematis hirsutissima	10
Clematis ligusticifolia	7
Fallugia paradoxa	3
Fendlera rupicola	1
Forestiera neomexicana	4
Fraxinus anomala	2
Gaultheria humifusa	1
Holodiscus dumosus	31
Jamesia americana	48
Juniperus communis	189
Linnaea borealis	55
Lonicera involucrata	151
Mahonia repens (*Berberis repens*)	181
Nolina microcarpa	3
Pachistima myrsinites	205
Pentaphylloides floribunda (*Potentilla fruticosa*)	13
Philadelphus spp.	1
Physocarpus monogynus	26
Poliomintha incana	1

Prunus spp.	1
Prunus virginiana	67
Purshia tridentata	11
Quercus gambelii	201
Quercus gambelii	26
(*Q. gambelii* x *Q. undulata*)	
Quercus undulata	16
(*Q. gambelii* x *Q. grisea*)	
Quercus undulata	9
(*Q. undulata* x *Q. grisea*)	
Rhus aromatica	33
(*R. trilobata*)	
Ribes spp.	3
Ribes cereum	70
Ribes inerme	48
Ribes montigenum	129
Ribes pinetorum	3
Ribes viscosissimum	1
Ribes wolfii	68
Robinia neomexicana	20
Rosa spp.	265
(Predominantly *R. woodsii* *R. fendleri*)	
Rubus deliciosus	5
Rubus neomexicanus	2
Rubus parviflorus	108
Rubus idaeus var. *strigosus*	41
(*R. strigosus*)	
Salix spp.	25
Salix depressa	1
(*S. bebbiana*)	
Salix scouleriana	47
Salix subcoerulea	1
Sambucus spp.	13
Sambucus racemosa	33
Shepherdia canadensis	88
Sorbus spp.	8
Sorbus scopulina	9
Swida sericea	30
(*Cornus stolonifera*)	
Symphoricarpos oreophilus	241
Toxicodendron rydbergii	13
(*Rhus radicans*)	
Vaccinium caespitosum	7
(*V. cespitosum*)	
Vaccinium myrtillus	221
(*V. oreophilum*)	
Xanthocephalum sarothrae	30
(*Gutierrezia sarothrae*)	
Yucca baccata	17
Yucca glauca	28

Graminoids

Agropyron spp.	9
Agropyron desertorum	1
Agropyron elongatum	2
Agropyron smithii	16
Agropyron subsecundum	10
Agropyron trachycaulum	19
Agrostis spp.	4
Agrostis gigantea	8
(*A. alba*)	
Agrostis scabra	17
Andropogon gerardi	34
Aristida spp.	1
Aristida arizonica	10
Aristida fendleriana	19
Aristida longiseta	8
Blepharoneuron tricholepis	64
Bouteloua curtipendula	29
Bouteloua gracilis	72
Bouteloua hirsuta	6
Bromopsis ciliata	334
(*Bromus ciliatus*)	
Bromopsis lanatipes	23
(*Bromus lanatipes*)	
Bromopsis porteri	5
(*Bromus anomalous*)	
Bromus spp.	16
Bromus polyanthus	2
Bromus tectorum	5
Calamagrostis canadensis	19
Calamagrostis inexpansa	2
Calamagrostis purpurascens	1
Carex spp.	100
Carex aurea	1
Carex bella	17
Carex brevipes	4
Carex deweyana	3
Carex ebenea	2
Carex elynoides	2
Carex festivella	1
Carex foenea	86
Carex geophila	5
Carex geyeri	49
Carex heliophila	31
Carex lanuginosa	1
Carex microptera	11
Carex norvegica ssp. *stevenii*	2
(*C. media*)	
Carex nova	1
Carex occidentalis	13
Carex praegracilis	2
Carex rossii	277
Carex rupestris	1
Carex scopulorum	1
Carex stenophylla ssp. *eleocharis*	1
(*C. eleocharis*)	
Carex utriculata	2
(*C. rostrata*)	
Carex vallicola	1
Cyperus fendlerianus	1
Danthonia intermedia	2
Danthonia parryi	38
Deschampsia caespitosa	13
Dichanthelium lanuginosum	4
(*Panicum huachucae*)	
Elymus spp.	7
Elymus ambiguus	1
Elymus canadensis	3
Elymus glaucus	31
Eragrostis spp.	1
Eragrostis intermedia	1
Festuca arizonica	154

Festuca brachyphylla	22
(*F. ovina* ssp. *brachyphylla*)	
Festuca sororia	28
Festuca thurberi	48
Glyceria elata	1
Glyceria striata	4
Hilaria jamesii	1
Juncus arcticus	3
(*J. balticus*)	
Juncus drummondii	1
Juncus longistylis	2
Juncus parryi	3
Koeleria macrantha	260
(*K. cristata*)	
Leucopoa kingii	1
Luzula parviflora	75
Luzula spicata	1
Lycurus phleoides	5
Mariscus schweinitzii	2
(*Cyperus schweinitzii*)	
Melica porteri	7
Muhlenbergia spp.	3
Muhlenbergia emersleyi	1
Muhlenbergia montana	191
Muhlenbergia monticola	2
Muhlenbergia pungens	1
Muhlenbergia racemosa	3
Muhlenbergia rigens	3
Muhlenbergia virescens	2
Muhlenbergia wrightii	1
Oryzopsis spp.	12
Oryzopsis asperifolia	52
Oryzopsis hymenoides	15
Oryzopsis micrantha	21
Panicum spp.	1
Panicum obtusum	1
Panicum virgatum	3
Phleum commutatum	7
(*P. alpinum*)	
Phleum pratensis	7
Piptochaetium fimbriatum	1
Poa spp.	7
Poa alpina	6
Poa arctica ssp. *grayana*	1
Poa compressa	2
Poa epilis	1
Poa fendleriana	308
Poa glauca var. *rupicola*	3
(*P. rupicola*)	
Poa leptocoma	13
Poa nemoralis var. *interior*	18
(*P. interior*)	
Poa nervosa var. *tracyi*	1
Poa palustris	1
Poa pratensis	78
Poa reflexa	13
Schizachne purpurascens	5
Schizachyrium scoparium	72
(*Andropogon scoparius*)	
Sitanion hystrix	216
(*S. longifolium*)	
Sorghastrum avenaceum	16
(*S. nutans*)	
Sporobolus cryptandrus	7
Sporobolus giganteus	1
Stipa spp.	10
Stipa comata	19
Stipa occidentalis	5
(*S. columbiana*)	
Stipa pringlei	2
Stipa robusta	1
Trisetum spicatum ssp. *montanum*	148
(*T. montanum*)	
Trisetum wolfii	2

Forbs

Abronia spp.	1
Achillea millefolium ssp. *lanulosa*	187
(*A. lanulosa*)	
Acomastylis rossii	8
(*Geum rossii*)	
Aconitum columbianum	11
Actaea rubra ssp. *arguta*	65
(*A. arguta*)	
Agastache pallidiflora	1
Ageratina herbacea	8
(*Eupatorium herbaceum*)	
Agoseris aurantiaca	6
Agoseris glauca	2
Agrimonia striata	3
Allium spp.	4
Allium cernuum	103
Allium geyeri	8
Ambrosia spp.	1
Androsace septentrionalis	63
Anemone spp.	1
Anemone canadensis	1
Angelica grayii	23
Antennaria spp.	38
Antennaria neglecta	47
(*A. marginata*)	
Antennaria parvifolia	2
(*A. aprica*)	
Antennaria rosea	169
Anticlea elegans	75
(*Zygadenus elegans*)	
Apocynum spp.	31
Apocynum androsaemifolium	19
Aquilegia spp.	13
Aquilegia caerulea	55
Aquilegia chrysantha	1
Aquilegia elegantula	81
Arabis spp.	65
Arabis drummondii	23
Arabis fendleri	57
Aralia spp.	1
Aralia nudicaulis	1
Arctium minus	1
Arenaria spp.	10
Arenaria fendleri	39
Arenaria lanuginosa	8
(*A. confusa*, *A. saxosa*)	

Arnica spp.	16
Arnica cordifolia	150
Arnica latifolia	5
Arnica mollis	10
Artemisia spp.	2
Artemisia campestris ssp. pacifica (A. pacifica)	4
Artemisia carruthii	52
Artemisia dracunculoides	17
Artemisia franserioides	139
Artemisia frigida	31
Artemisia ludoviciana	144
Artemisia parryi	1
Artemisia scopulorum	2
Asclepias spp.	1
Asclepias asperula (A. capricorna)	1
Asclepias tuberosa	1
Asclepias viridiflora	2
Asparagus officinalis	1
Aster spp.	9
Aster foliaceus	1
Aster glaucodes	7
Aster laevis	6
Astragalus spp.	4
Astragalus adsurgens	2
Astragalus drummondii	6
Astragalus flexuosus	8
Astragalus humistratus	1
Astragalus lonchocarpus	1
Astragalus parryi	1
Astragalus tenellus	1
Astragalus wingatanus	1
Bahia dissecta	34
Balsamorhiza sagittata	2
Batrachium trichopyllus (Ranunculus trichophyllus)	1
Besseya plantaginea	6
Bidens bipinnata	2
Bistorta bistortoides (Polygonum bistortoides)	11
Bistorta vivipara (Polygonum viviparum)	13
Brickellia spp.	15
Brickellia brachyphylla	2
Brickellia grandiflora	30
Brickellia microphylla (B. scabra)	1
Calochortus gunnisonii	7
Caltha leptosepala	16
Calypso bulbosa	19
Campanula rotundifolia	119
Cardamine cordifolia	24
Castilleja spp.	19
Castilleja integra	3
Castilleja linariaefolia	17
Castilleja lineata	8
Castilleja miniata	33
Castilleja occidentalis	2
Castilleja rhexifolia	6
Castilleja sulphurea	2
Cerastium spp.	2
Cerastium arvense	5
Chaenactis spp.	2
Chaenactis douglasii	6
Chamaepericlymenum canadense (Cornus canadensis)	1
Chamaesyce albomarginata (Euphobia albomarginata)	1
Chamaesyce fendleri (Euphobia fendleri)	2
Chamerion angustifolium (Epilobium angustifolium)	137
Cheilanthes spp.	6
Cheilanthes fendleri	7
Chenopodium spp.	8
Chenopodium aff album	12
Chenopodium fremontii	6
Chenopodium graveolens	2
Cicuta douglasii	2
Circaea alpina	2
Cirsium spp.	42
Cirsium canescens	1
Cirsium pallidum	1
Cirsium parryi	10
Cirsium scopulorum	2
Cirsium undulatum	1
Clementsia rhodantha (Sedum rhodanthum)	3
Coeloglossum viride (Habenaria viridus)	1
Comandra umbellata ssp. pallida (C. pallida)	31
Commelina dianthifolia	2
Conioselinum scopulorum	1
Conopholis mexicana	2
Conyza canadensis	1
Conyza schiedeana	1
Corallorhiza spp.	10
Corallorhiza maculata	51
Corallorhiza striata	11
Corallorhiza trifida	2
Coreopsis lanceolata	1
Corydalis aurea	1
Corydalis caseana	2
Coryphant spp.	2
Cosmos parviflora	2
Crepis spp.	2
Cryptantha jamesii	9
Cryptantha thyrsiflora	3
Cryptogramma crispa	2
Cynoglossum officinale	4
Cypripedium calceolus	1
Cystopteris fragilis	40
Dalea spp.	1
Dalea candida var. oligophylla (Petalostemon candidus)	4
Dalea purpurea (Petalostemon purpurea)	8
Delphinium spp.	1
Delphinium barbeyi	29
Descurainia spp.	2
Descurainia richardsonii	12
Disporum trachycarpum	29

Dithyrea wislizeni	1
Dodecatheon ellisiae	2
Dodecatheon pulchellum	1
Draba spp.	32
Draba aurea	26
Draba helleriana	33
Draba smithii	1
Draba spectabilis	2
Draba streptocarpa	19
Drymocallis fissa	10
(*Potentilla fissa*)	
Dryopteris filix-mas	1
Dugaldia hoopesii	15
(*Helenium hoopsii*)	
Echinocereus spp.	18
Echinocereus fendleri	1
Echinocereus viridiflorus	2
Epilobium spp.	19
Epilobium adenocaulon	3
Epilobium ciliatum	3
(*E. glandulosum*)	
Epilobium hornemannii	8
Equisetum spp.	5
Equisetum arvense	15
Erigeron spp.	17
Erigeron canus	1
Erigeron compositus	2
Erigeron concinnus	22
Erigeron coulteri	14
Erigeron divergens	5
Erigeron elatior	1
Erigeron eximius	221
(*E. superbus*)	
Erigeron flagellaris	95
Erigeron formosissimus	63
Erigeron melanocephalus	4
Erigeron peregrinus	32
Erigeron platyphyllus	1
Erigeron speciosus var. *speciosus*	25
Erigeron subtrinervis	72
Erigeron vetensis	10
Eriogonum alatum	46
Eriogonum annuum	1
Eriogonum bakeri	1
Eriogonum jamesii	38
Eriogonum microthecum	3
Eriogonum racemosum	38
Eriogonum umbellatum	7
Erysimum spp.	3
Erysimum asperum	4
Erysimum capitatum	52
Erythronium grandiflorum	8
Euphorbia spp.	2
Euphorbia robusta	5
Fragaria americana	122
(*F. vesca* var. *bracteata*)	
Fragaria ovalis	302
(*F. virginiana* var. *glauca*)	
Frasera speciosa	38
(*Swertia radiata*)	
Gaillardia aristata	1
Gaillardia pinnatifida	1
Galium spp.	5
Galium aparine	6
Galium boreale	56
Galium trifidum	45
Galium triflorum	52
Gaura spp.	2
Gaura neomexicana	1
Gayophytum diffusum	1
(*G. nuttallii*)	
Gentiana spp.	6
Gentianella amarella ssp. *acuta*	25
(*Gentiana amarella, G. strictiflora*)	
Gentianella amarella ssp. *heterosepala*	23
(*Gentiana heterosepala*)	
Geranium spp.	7
Geranium caespitosum	91
(*G. fremontii*)	
Geranium richardsonii	185
Geum aleppicum ssp. *strictum*	3
(*G. strictum*)	
Geum macrophyllum	3
Gilia spp.	2
Gilia pinnatifida var. *calcarea*	9
Gnaphalium spp.	4
Gnaphalium viscosum	6
(*G. macounii*)	
Gnaphalium wrightii	1
Goodyera oblongifolia	137
Goodyera repens	15
Habenaria spp.	5
Hackelia spp.	4
Hackelia floribunda	3
Harbouria trachypleura	19
Hedeoma drummondii	1
Helianthella parryi	46
Helianthella quinquenervis	2
Helianthus annuus	1
Heliomeris multiflora	29
(*Viguiera multiflora*)	
Heliopsis helianthoides	1
(*H. scabra*)	
Heracleum sphondylium	33
(*H. lanatum*)	
Herrickia horrida	2
(*Aster horridus*)	
Heterotheca fulcrata	123
(*Chrysopsis villosa* var. *foliosa*)	
Heuchera spp.	20
Heuchera parvifolia	9
Hieracium spp.	6
Hieracium fendleri	38
Hieracium geyeri	1
Hieracium gracile	9
Hippochaete hyemalis	5
(*Equisetum hiemale*)	
Hippochaete laevigata	2
(*Equisetum laevigatum*)	
Humulus lupulus	1
Hydrophyllum fendleri	17
Hymenopappus filifolius	2
(*H. lugens*)	

Hymenopappus radiatus	8
Hymenoxys spp.	5
Hymenoxys acaulis	43
Hymenoxys grandiflora	1
Hymenoxys ivesiana	4
Hymenoxys richardsonii	46
Hypericum formosum	1
Ipomoea coccinea	1
Ipomopsis aggregata (*Gilia aggregata*)	90
Iris missouriensis	23
Krascheninnikovia lanata (*Ceratoides lanata, Eurotia lanata*)	5
Kuhnia rosmarinifolia (*K. chlorolepis*)	1
Lactuca serriola (*L. scariola*)	2
Lappula spp.	1
Lappula redowskii	2
Lathyrus spp.	203
Lathyrus arizonicus x graminifolius	1
Lathyrus graminifolius	7
Leonurus cardiaca	1
Lepidium spp.	4
Lepidium virginicum	1
Leptodactylon pungens	1
Lesquerella sp.	1
Lesquerella alpina (*L. subumbellata*)	1
Lesquerella fendleri	14
Lesquerella montana	6
Leucanthemum vulgare (*Chrysanthemum leucanthemum*)	1
Leucelene ericoides	2
Liatrus punctata	17
Ligularia amplectens (*Senecio amplectens*)	39
Ligularia bigelovii (*Senecio bigelovii*)	11
Ligularia pudica (*Senecio pudicus*)	2
Ligusticum porteri	108
Limnorchis saccata (*Habenaria saccata*)	3
Linanthus nuttallii (*Linanthastrum nuttallii*)	1
Linum spp. (annuals)	4
Linum aristatum	1
Listera cordata	21
Lithospermum multiflorum	119
Lotus wrightii	32
Lupinus spp.	11
Lupinus argenteus	39
Lupinus kingii	4
Macromeria viridiflora	2
Mammalaria spp.	12
Medicago lupulina	1
Melampodium cinereum	2
Melilotus alba	2
Melilotus officinalis	3
Mentha arvensis	8
Mentzelia pumila	2
Mertensia spp.	7
Mertensia ciliata	96
Mertensia franciscana	24
Mertensia lanceolata	36
Mertensia viridi	3
Mimulus guttatus	4
Mitella pentandra	24
Moehringia macrophylla (*Arenaria macrophylla*)	7
Monarda fistulosa var. *menthaefolia* (*M. menthaefolia*)	4
Moneses uniflora (*Pyrola uniflora*)	75
Monotropa latisquama	6
Oenothera caespitosa	9
Oenothera coronopifolia	4
Oenothera villosa (*O. strigosa*)	1
Opuntia spp. (Prickly pears)	1
Opuntia engelmannii	16
Opuntia imbricata	3
Opuntia polyacantha	24
Oreochrysum parryi (*Haplopappus parryi*)	252
Oreoxis alpina	3
Oreoxis bakeri	3
Orobanche sp.	1
Orobanche fasciculata	1
Orthilia secunda (*Pyrola secunda, Ramischia secunda*)	224
Orthocarpus luteus	1
Orthocarpus purpureo-albus	2
Osmorhiza chilensis	3
Osmorhiza depauperata (*O. obtusa*)	181
Oxalis spp.	7
Oxalis violaceae	5
Oxybaphus linearis (*Mirabilis linearis*)	14
Oxypolis fendleri	28
Oxytropis spp.	3
Oxytropis lambertii	7
Oxytropis sericea	1
Parnassia fimbriata	2
Parthenocissus spp.	3
Pedicularis spp.	1
Pedicularis bracteosa	11
Pedicularis canadensis	2
Pedicularis grayii	37
Pedicularis groenlandica	1
Pedicularis parryi	1
Pedicularis racemosa	96
Pennellia micrantha	1
Penstemon spp.	2
Penstemon barbatus	107
Penstemon bridgesii	7
Penstemon griffinii (*P. oliganthus*)	23
Penstemon linarioides	37

Penstemon virens	8
Penstemon virgatus	34
Penstemon whippleanus	24
Petasites sagittata	4
Phacelia spp.	7
Phacelia heterophylla	15
Phacelia ivesiana	2
Phacelia neomexicana	1
Phlox spp.	2
Phlox condensata	3
(*P. caespitosa*)	
Phlox nana	5
Physalis virginiana var. *sonorae*	2
(*P. longiflora*)	
Physaria acutifolia	1
(*P. australis*)	
Piperia unalascensis	1
(*Habenaria unalascensis*)	
Plantago major	1
Pneumonanthe calycosa	4
(*Gentiana parryi*)	
Polemonium spp.	1
Polemonium foliosissimum	3
Polemonium pulcherrimum ssp. *delicatum*	79
(*P. delicatum*)	
Polemonium viscosum	1
Polygala spp.	1
Polygonum sawatchensis	60
Potentilla spp.	5
Potentilla anserina	1
Potentilla concinna	2
Potentilla crinita	8
Potentilla diversifolia	7
Potentilla gracilis var. *pulcherrima*	56
Potentilla hippiana	92
Potentilla norvegica	1
Potentilla pennsylvanica	6
Primula parryi	7
Prunella vulgaris	7
Pseudocymopteris montanus	249
Pseudostellaria jamesiana	22
(*Stellaria jamesiana*)	
Psoralea tenuiflora	5
Pteridium aquilinum	10
Pterospora andromeda	34
Pulsatilla patens	35
Pyrola asarifolia	29
Pyrola chlorantha	70
(*P. virens*)	
Pyrola minor	4
Pyrola picta	11
Ranunculus spp.	4
Ranunculus alismaefolius	2
Ranunculus cardiophyllus	1
Ranunculus eschscholtzii	7
Ranunculus inamoenus	2
Ranunculus macounnii	2
Ranunculus uncinatus	2
Ratibida columnaris	2
Rhodiola integrifolia	14
(*Sedum rosea*)	

Rudbeckia hirta	6
Rudbeckia laciniata	14
Rumex crispus	1
Saxifraga spp.	3
Saxifraga bronchialis	51
Saxifraga odontoloma	9
Saxifraga rhomboidea	6
Scutellaria spp.	1
Sedum spp.	6
Sedum cockerellii	2
Sedum lanceolatum	26
(*S. stenopetalum*)	
Senecio spp.	5
Senecio atratus	10
Senecio crocatus	1
Senecio dimorphophyllus	1
Senecio eremophilus	22
Senecio fendleri	110
Senecio hartianus	1
Senecio integerrimus	2
Senecio neomexicanus	91
Senecio neomexicanus var. *mutabilis*	2
(*S. mutabilis*)	
Senecio sanguisorboides	13
Senecio serra	10
Senecio streptanthifolius	28
(*S. cymbalarioides*)	
Senecio triangularis	16
Senecio wootoni	62
Sibbaldia procumberns	14
Sidalcea neomexicana	6
Silene spp.	4
Silene acaulis	2
Silene antirrhina	1
Silene laciniata	1
Silene menziesii	21
Silene scouleri	39
Sisymbrium spp.	1
Smilacina racemosa	126
Smilacina stellata	130
Solidago spp.	56
Solidago canadensis	3
Solidago missouriensis	10
Solidago missouriensis var. *extraria*	1
Solidago nana	3
Solidago sparsiflora	23
Solidago spathulata var. *neomexicana*	39
(*S. decumbens*)	
Solidago spathulata var. *nana*	1
Solidago wrightii	3
Sphaeralcea coccinea	1
Stachys coccinea	2
Stachys palustris	3
Stellaria spp.	10
Stellaria laeta	16
(*S. longipes*)	
Stellaria umbellata	10
Stephanomeria exigua	1
Streptanthus spp.	1
Streptopus amplexifolius	45
Swertia perennis	2
Taraxacum spp.	1

Taraxacum officinale	97
Tetradymia canescens	1
Teucrium spp.	1
Thalictrum fendleri	181
Thelesperma filifolium	2
Thelesperma magapotamicum	5
Thelypodiopsis linearifolia	12
Thermopsis spp.	57
Thlaspi spp.	5
Thlaspi arvense	3
Thlaspi montanum var. *montanum* (*T. fendleri*)	64
Townsendia spp.	2
Townsendia eximia	9
Townsendia formosa	2
Tradescantia occidentalis	1
Tragia ramosa	4
Tragopogon spp.	13
Tragopogon dubius	3
Trautvetteria carolinensis (*T. grandis*)	12
Trifolium spp.	15
Trifolium brandegei	4
Trifolium dasyphyllum	9
Trifolium dubium	1
Trifolium parryi	1
Trifolium wormskjoldii	1
Trollius laxis	11
Urtica spp.	7
Urtica dioica	3
Valeriana spp.	3
Valeriana capitata ssp. *acutiloba*	16
Valeriana edulis	7
Veratrum californicum	16
Verbascum thapsus	10
Veronica spp.	3
Veronica americana	1
Veronica serphyllifolia	1
Veronica wormskjoldii	14
Vicia americana	137
Vicia ludoviciana var. *texana* (*V. exigua*)	2
Vicia pulchella	1
Viguiera spp.	2
Viola spp.	2
Viola adunca	37
Viola canadensis	157
Viola nephrophylla	7
Woodsia ssp.	5
Woodsia oregana	2
Wyethia amplexicaulis	4
Wyethia arizonica	6
Zygadenus ssp.	38

Keys to the Forest Series and Habitat Types of Northern New Mexico and Southern Colorado

Before attempting to apply keys for field identification, familiarization with the following guidelines is necessary.

1. Locate that portion of the stand that, in your judgment, best represents the typical vegetation of the stand. The tree canopy should be mature and the undergrowth should not be severely disturbed. Extrapolation from the nearest mature stand occupying a similar site may be necessary in some areas of widespread disturbance.
2. Note mature trees and their reproduction, by species, within the stand. Particular attention must be given to tree reproduction; reference to trees in the key primarily concerns regeneration since habitat types are based on potential climax, not necessarily current conditions.
3. Accurately identify and estimate cover of dominant shrub and herb species within the stand and note presence of indicator species given in the key that may have minor cover in the stand to be sampled. Careful comparisons of the descriptive material and the vegetation being investigated will usually allow identification of the correct habitat type even in the absence of a species used in the habitat type name.
4. Note the physical setting of the stand, including elevation, aspect, percent slope, landform, and soil depth and coarse fragments.
5. Identify the habitat type by following the key.
6. If difficulty arises in habitat type identification, compare the stand with the synoptic descriptions and species frequency and cover tables given for the series and types in question and decide which best fits the stand characteristics.
7. If it becomes apparent that an undescribed habitat type has been found, the stand should be measured thoroughly or its precise location given to the USDA Forest Service Regional Ecologist.
8. The following canopy coverage terms are used in the keys. In stands where dense shading or heavy duff accumulation has resulted in an unusually sparse undergrowth, adjust definitions to the next lower coverage class:

(1) "scarce" = less than 1% cover, versus "common" = greater than 1% cover;
(2) "poorly represented" = less than 5% cover, versus "well represented" = greater than 5% cover;
(3) "abundant" = greater than 25% cover.

Forest Series Key

1. Forests of talus or debris slopes with fragmental soils (cobbles and stones greater than 90% soil volume) and poorly developed undergrowths ———————————— Scree Forests
1. Forests on other sites with relatively well-developed undergrowths (although some sites may be rocky) ———————————— 2
2. Forests of streamsides with *Populus angustifolia* and/or *Alnus tenuifolia* generally present ———————————— Riparian Forests
2. Forests of canyons, sideslopes, and ridges; sometimes of bottoms, protected benches, or seeps, but then *Populus angustifolia* and *Alnus tenuifolia* both absent ———————————— 3
3. *Pinus aristata* or *P. flexilis* well represented and reproducing successfully, usually dominant in open stands ——— *Pinus aristata* and *Pinus flexilis* Series
3. *Pinus aristata* and *P. flexilis* both poorly represented or absent ———————————— 4
4. *Abies lasiocarpa* and/or *Picea engelmannii* present and reproducing successfully, dominant over regeneration of *Abies concolor* and *Pseudotsuga menziesii* (if either are present) ———————————— *Picea engelmannii* and *Abies lasiocarpa* Series
4. *Abies lasiocarpa* and/or *Picea engelmannii* not the indicated climax, if present, minor in regeneration relative to other conifers ———————————— 5
5. *Picea pungens*, *Abies concolor*, and/or *Pseudotsuga menziesii* present and reproducing successfully, not accidental ——— *Picea pungens*, *Abies concolor*, or *Pseudotsuga menziesii* Series
5. *Picea pungens*, *Abies concolor*, and/or *Pseudotsuga menziesii* not the indicated climax, but may be accidental ———————————— *Pinus ponderosa* Series

Scree Forests

1. *Picea engelmannii* and/or *Abies lasiocarpa* present and reproducing successfully ———————————— 2
1. *Picea engelmannii* and/or *Abies lasiocarpa* not the indicated climax ———————————— 3
2. *Picea engelmannii* dominant ——— PIEN/SABR HT
2. *Picea engelmannii* scarce or absent ———————————— ABLA/SABR HT
3. *Abies concolor* and/or *Pseudotsuga menziesii* present and reproducing successfully ———————————— 4
3. *Abies concolor* and/or *Pseudotsuga menziesii* not the indicated climax ———————————— 5
4. *Abies concolor* dominant ——— ABCO/HODU HT
4. *Abies concolor* scarce or absent ———————————— PSME/HODU HT
5. *Pinus aristata* present ——— PIAR/RIMO HT
5. *Pinus aristata* absent ——— PIPO/RIIN HT

Riparian Forests

1. *Picea engelmannii* present and reproducing successfully ———————————— PIEN/HESP HT
1. *Picea engelmannii* not the indicated climax ——— 2
2. *Picea pungens* and/or *Abies concolor* present and reproducing successfully ———————————— 3
2. *Picea pungens* or *Abies concolor* not the indicated climax ———————————— PIPO/POPR HT
3. *Picea pungens* present ———————————— 4
3. *Picea pungens* absent ——— ABCO/GATR HT
4. *Swida sericea* present ——— PIPU/SWSE HT
4. *Swida sericea* absent ——— PIPU/POPR HT

***Pinus aristata* and *Pinus flexilis* Series**

1. *Pinus aristata* well represented and reproducing successfully, *P. flexilis* scarce or absent; undergrowth dominated by grasses, *Festuca thurberi* or *F. arizonica*. *Picea engelmannii* or *Pseudotsuga menziesii* sometimes also present ——————————— 2
1. *Pinus flexilis* well represented, *P. aristata* scarce or absent; undergrowth dominated by shrubs, *Arctostaphylos uva-ursi* and/or *Juniperus communis* ——————————————— PIFL/ARUV HT
2. High-elevation mid and upper slopes and rocky ridges, generally over 10,500-feet (3,200-m) elevation, *Festuca thurberi* common ——— PIAR/FETH HT
2. Lower elevation, steep slopes and rocky ridges, generally under 9,800-feet (3,000-m) elevation, *Festuca thurberi* absent, *F. arizonica* common ——————————————— PIAR/FEAR HT

***Picea engelmannii* and *Abies lasiocarpa* Series**

1. Undergrowth relatively well developed, although sometimes poorly represented; at least one understory species over 1% cover ————————— 2
1. Vascular plant undergrowth very sparse (seldom exceeding 10% total cover); often every species less than 1% cover ———————— ABLA/Moss HT
2. *Mertensia ciliata*, *Oxypolis fendleri*, *Cardamine cordifolia*, or other wet-site plants well represented; forests of high-elevation seeps and poorly drained benches ——————————————— ABLA/MECI HT
2. Wet-site plants poorly represented or absent — 3
3. *Vaccinium scoparium* or *V. myrtillus* well represented ——————————————— 4
3. *Vaccinium scoparium* or *V. myrtillus* poorly represented or absent ————————————— 7
4. *Linnaea borealis* well represented ——————————————— ABLA/VAMY-LIBO HT
4. *Linnaea borealis* poorly represented or absent – 5
5. *Polemonium pulcherrimum* ssp. *delicatum* or *Ligularia amplectens* common ——————————————— PIEN/VAMY/POPU HT
5. *Polemonium pulcherrimum* ssp. *delicatum* or *Ligularia amplectens* scarce or absent —————— 6
6. *Rubus parviflorus* well represented ——————————————— ABLA/VAMY-RUPA HT
6. *Rubus parviflorus* poorly represented or absent — ——————————————— ABLA/VAMY HT
7. *Rubus parviflorus* well represented ——————————————— ABLA/RUPA HT
7. *Rubus parviflorus* poorly represented or absent — ——————————————— 8
8. *Festuca thurberi* or *F. arizonica* scarce or absent; forests of the lower subalpine zone ABLA/EREX HT
8. *Festuca thurberi* or *F. arizonica* common; high-elevation open forests ————— PIAR/FETH HT

***Picea pungens*, *Abies concolor*, and *Pseudotsuga menziesii* Series**

1. *Vaccinium* spp. well represented ——————————————— ABCO/VAMY HT
1. *Vaccinium* spp. poorly represented or absent — 2
2. *Picea pungens*, *Acer glabrum*, or *Erigeron eximius* common ——————————————— 3
2. *Picea pungens*, *Acer glabrum*, or *Erigeron eximius* scarce or absent ————————————— 9
3. *Picea pungens* well represented, reproducing, and the indicated climax or co-climax —————— 4
3. *Picea pungens* absent or minor relative to *Abies concolor* and *Pseudotsuga menziesii* ——————— 8
4. *Linnaea borealis* well represented ——————————————— PIPU/LIBO HT
4. *Linnaea borealis* poorly represented or absent – 5
5. *Carex foenea* abundant ———— PIPU/CAFO HT
5. *Carex foenea* less than 25% cover —————— 6
6. *Festuca arizonica* well represented ——————————————— PIPU/FEAR HT
6. *Festuca arizonica* poorly represented or absent — ——————————————— 7
7. *Arctostaphylos uva-ursi* well represented ——————————————— PIPU/ARUV HT
7. *Arctostaphylos uva-ursi* poorly represented or absent ——————————————— PIPU/EREX HT
8. *Acer glabrum* dominant relative to *Erigeron eximius* or *Bromopsis ciliata*; undergrowths dominated by shrubs ——————————— ABCO/ACGL HT
8. *Acer glabrum* minor or absent relative to *Erigeron eximius* or *Bromopsis ciliata*; undergrowths dominated by herbs ————— ABCO/EREX HT
9. *Abies concolor* common and reproducing successfully, not accidental ————————————— 10
9. *Abies concolor* scarce or absent —————— 13
10. *Artcostaphylos uva-ursi* or *Quercus gambelii* well represented ——————————————— 11
10. *Arctostaphylos uva-ursi* or *Quercus gambelii* poorly represented or absent ————————————— 12
11. *Arctostaphylos uva-ursi* well represented; *Quercus gambelii* poorly represented or absent ——————————————— ABCO/ARUV HT
11. *Arctostaphylos uva-ursi* poorly represented or absent; *Quercus gambelii* well represented ——————————————— ABCO/QUGA HT
12. *Festuca arizonica* common; other graminoids usually with greater than 1% cover – ABCO/FEAR HT
12. *Festuca arizonica* scarce or absent; all other herb species usually with less than 1% cover ——————————————— ABCO/Sparse HT
13. *Pinus flexilis* dominant or codominant with *Pseudotsuga menziesii*; *Arctostaphylos uva-ursi* and/or *Juniperus communis* well represented ——————————————— PIFL/ARUV HT
13. *Pinus flexilis* minor or absent, *Arctostaphylos uva-ursi* and *Juniperus communis* poorly represented or absent ——————————————— 14
14. *Quercus gambelii* well represented ——————————————— PSME/QUGA HT
14. *Quercus gambelii* poorly represented or absent — ——————————————— 15
15. *Pinus aristata* present and reproducing successfully ——————————————— PIAR/FEAR HT
15. *Pinus aristata* scarce or absent PSME/FEAR HT

***Pinus ponderosa* Series**

1. *Arctostaphylos uva-ursi* well represented ———————————————— PIPO/ARUV HT
1. *Arctostaphylos uva-ursi* poorly represented or absent ———————————————— 2
2. *Artemisia arbuscula* well represented ———————————————— PIPO/ARAR HT
2. *Artemisia arbuscula* poorly represented or absent ———————————————— 3
3. *Quercus gambelii* or *Q. undulata* well represented ———————————————— 4
3. *Quercus gambelii* or *Q. undulata* poorly represented or absent ———————————————— 5
4. *Quercus undulata* well represented ———————————————— PIPO/QUUN HT
4. *Quercus undulata* poorly represented or absent ———————————————— PIPO/QUGA HT
5. *Bouteloua gracilis* present and dominant or codominant in the undergrowth ———————————————— 6
5. *Bouteloua gracilis* absent or minor ———————————————— 7
6. *Festuca arizonica* present ———————————————— PIPO/FEAR HT, BOGR phase
6. *Festuca arizonica* absent ——————— PIPO/BOGR HT
7. *Festuca arizonica* and/or *Danthonia parryi* well represented ———————————————— PIPO/FEAR HT
7. *Festuca arizonica* and *Danthonia parryi* poorly represented or absent ———————————————— 8
8. *Muhlenbergia montana* common ———————————————— PIPO/MUMO HT
8. *Muhlenbergia montana* scarce or absent; woodlands on eolian sands ———————————————— PIPO/ORHY HT

APPENDIX 3

Successional Status of Major Tree Species Within Habitat Types (Excluding Scree and Riparian Habitat Types)

C = major climax **S = major seral**
c = minor climax **s = minor seral**

Habitat type	PIEN	ABLA	PIFL	PIPU	ABCO	PSME	PIPO	POTR	PIAR	QUGA	PIED	JUSC	JUMO
PIAR/FETH	C								C				
PIAR/FEAR						C		s	C				
PIEN/VAMY/POPU													
PIEN ph.	C	c							s				
ABLA ph.	C	C						s					
ABLA/MECI	C	C						s					
ABLA/Moss	C	C				s		s	s				
ABLA/VAMY	C	C	s		s	s		S	s				
ABLA/VAMY-LIBO	C	C		s	S	S		S					
ABLA/VAMY-RUPA	C	C			s	S		S					
ABLA/RUPA	C	C				S		S					
ABLA/EREX	C	C	s	s	S	S		S					
PIPU/LIBO	c	c	S	C	C	C		S					
PIPU/EREX	c		S	C	C	C		S					
PIPU/CAFO			s	C	c	C	S	S					
PIPU/ARUV			S	C	C	C	S	S					
PIPU/FEAR			s	C	c	C	S	S					
ABCO/VAMY	c	c	s	c	C	C	s	S					
ABCO/EREX	c		s	c	C	C	s	S					
ABCO/ACGL	c		s	c	C	C	s	S		s			
ABCO/Sparse			s	c	C	C	s	S	s				
ABCO/ARUV			s		C	C	S	s					
ABCO/FEAR			s		C	C	S	s					
ABCO/QUGA			s		C	C	S	s		S			
PIFL/ARUV	c		C			C		S					
PSME/FEAR			s			C	S	s			s		
PSME/QUGA													
FEAR ph.						C	S			S	s	s	
QUGA ph.						C	S			S	s	s	
PIPO/ARUV						c	C						
PIPO/FEAR													
DAPA ph.							C	s					
FEAR ph.							C				s		
BOGR ph.							C				c	c	c
PIPO/QUGA													
PIED ph.							C			S	C	c	c
FEAR ph.							C			S		c	
QUGA ph.							C			S	c	c	
PIPO/MUMO							C			s	c		c
PIPO/BOGR													
SCSC ph.							C				C	c	c
BOGR ph.							C				C	c	c
PIPO/QUUN							C			S	C	c	c
PIPO/ARAR							c			s	C	C	
PIPO/ORHY							C						c

APPENDIX 4

Average Tree Density or Average Shrub and Herbaceous Cover and Constancy for Habitat Types

In these tables, tree size classes are defined as follows:

Yng regen = trees less than 2 inches (5 cm) d.b.h.
Adv regen = trees 2–10 inches (5–25 cm) d.b.h.
Mature = trees larger than 10 inches (25 cm) d.b.h.

Occurrence of each species in each habitat type and phase is indicated by two values separated by a slash. The first indicates the mean density (in percent) per plot for the trees or mean cover (in percent) for the shrubs, graminoids, and forbs. In all cases, however, the first value is the mean for only the plots in which the species was present. The value to the right of the slash is the constancy for each species in the habitat type or phase; it is the percentage of the total number of plots in the group in which the species was found. A dot indicates that the species was not found in a group.

Table A1.— *Pinus aristata* series.

Species	PIAR/FETH HT (N = 7)	PIAR/FEAR HT (N = 4)
Trees		
Abies lasiocarpa		
Yng regen	<1/14	.
Adv regen	.	.
Mature	.	.
Picea engelmannii		
Yng regen	4/71	.
Adv regen	3/86	.
Mature	2/57	.
Pinus aristata		
Yng regen	3/71	3/100
Adv regen	7/71	6/100
Mature	5/86	7/100
Pinus flexilis		
Yng regen	<1/14	.
Adv regen	.	.
Mature	.	<1/25
Populus tremuloides		
Yng regen	.	2/25
Adv regen	.	.
Mature	.	.
Pseudotsuga menziesii		
Yng regen	.	2/50
Adv regen	.	2/50
Mature	.	2/75
Shrubs		
Juniperus communis	<1/14	<1/25
Ribes cereum	<1/14	2/50
Ribes montigenum	<1/43	.
Ribes wolfii	.	.
Symphoricarpos oreophilus	<1/29	1/25

Species	PIAR/FETH HT (N = 7)	PIAR/FEAR HT (N = 4)
Graminoids		
Carex rossii	<1/71	<1/50
Festuca arizonica	1/14	14/100
Festuca thurberi	22/100	.
Koeleria macrantha	<1/29	3/100
Muhlenbergia montana	<1/14	5/50
Poa fendleriana	<1/71	2/75
Forbs		
Achillea millefolium	<1/86	<1/25
Arnica cordifolia	2/29	.
Artemisia franserioides	<1/43	<1/75
Chamerion angustifolium	<1/71	.
Erigeron eximius	.	2/25
Fragaria americana	<1/14	<1/25
Fragaria ovalis	<1/29	.
Galium triflorum	.	.
Geranium caespitosum	<1/14	<1/25
Geranium richardsonii	<1/14	.
Oreochrysum parryi	<1/43	<1/25
Polemonium pulcherrimum	<1/57	.
Pseudocymopteris montanus	<1/29	.
Saxifraga bronchialis	<1/57	.
Senecio atratus	<1/29	.
Smilacina stellata	<1/29	<1/25
Thalictrum fendleri	<1/29	.
Trifolium dasyphyllum	<1/29	<1/50

Table A2.— *Picea engelmannii* and *Abies lasiocarpa* series.

Species	PIEN/VAMY/POPU HT PIEN ph. (N = 15)	PIEN/VAMY/POPU HT ABLA ph. (N = 38)	ABLA/MECI HT (N = 14)	ABLA/Moss HT (N = 14)	ABLA/VAMY HT (N = 62)	ABLA/VAMY-LIBO HT (N = 21)	ABLA/VAMY-RUPA (N = 7)	ABLA/RUPA HT (N = 11)	ABLA/EREX HT (N = 40)
Trees									
Abies concolor									
Yng regen	.	.	.	.	<1/6	4/29	<1/14	.	2/25
Adv regen	.	.	.	.	<1/6	<1/29	1/14	.	<1/22
Mature	.	.	.	.	<1/3	<1/5	<1/14	.	<1/15
Abies lasiocarpa									
Yng regen	2/67	63/100	37/100	38/93	64/97	68/100	59/100	65/100	38/97
Adv regen	2/47	14/100	13/100	9/93	15/89	17/86	9/100	16/100	10/97
Mature	<1/27	4/95	2/86	1/64	3/77	<1/29	2/71	3/82	2/57
Picea engelmannii									
Yng regen	43/93	31/95	19/100	29/100	34/98	43/90	29/100	11/73	21/92
Adv regen	24/100	14/95	9/93	26/100	14/95	13/90	8/100	7/73	9/90
Mature	14/100	11/100	10/100	8/100	7/94	5/76	6/100	6/100	6/85
Picea pungens									
Yng regen	.	.	.	.	<1/2	<1/14	.	.	<1/7
Adv regen	.	.	.	.	<1/2	<1/19	.	.	<1/5
Mature	.	.	.	.	<1/2	<1/10	.	.	<1/7
Pinus aristata									
Yng regen	.	.	.	<1/14	<1/2	.	.	.	.
Adv regen	<1/7	.	.	3/21	<1/2	.	.	.	.
Mature	<1/7	.	.	<1/14	<1/2	.	.	.	.
Pinus flexilis									
Yng regen	.	.	.	.	<1/5	<1/19	.	.	.
Adv regen	.	.	.	.	<1/6	.	.	<1/9	<1/5
Mature	.	<1/3	.	.	<1/3	.	.	.	<1/2
Populus tremuloides									
Yng regen	.	.	.	<1/7	<1/13	<1/14	2/14	<1/27	3/20
Adv regen	.	.	.	<1/14	3/18	3/33	.	<1/18	1/30
Mature	.	.	<1/7	<1/7	<1/3	<1/5	.	<1/27	<1/20
Pseudotsuga menziesii									
Yng regen	.	.	.	<1/14	<1/8	11/48	5/29	.	1/27
Adv regen	.	.	.	<1/7	<1/23	3/52	2/43	<1/27	1/35
Mature	.	.	.	<1/29	1/19	4/62	1/57	<1/36	2/42
Shrubs									
Acer glabrum	.	.	.	<1/7	<1/3	<1/29	2/43	2/27	<1/22
Juniperus communis	<1/13	<1/3	.	1/43	<1/31	<1/43	<1/14	.	<1/17
Linnaea borealis	.	.	.	.	<1/18	25/100	<1/14	.	<1/13
Lonicera involucrata	<1/13	<1/58	3/79	<1/14	<1/44	<1/71	3/100	2/82	1/52
Mahonia repens	.	.	.	<1/14	<1/15	<1/24	<1/14	<1/27	<1/27
Moneses uniflora	<1/27	<1/34	<1/79	<1/7	<1/32	<1/24	<1/14	<1/18	<1/27
Orthilia secunda	<1/40	<1/68	<1/79	<1/50	<1/73	<1/90	<1/86	1/82	<1/75
Pachistima myrsinites	<1/7	.	<1/7	<1/14	<1/47	6/57	4/71	2/73	2/50
Ribes montigenum	<1/80	<1/66	4/86	<1/7	<1/32	<1/24	<1/43	<1/36	1/57
Ribes wolfii	<1/20	<1/24	<1/43	.	<1/19	<1/14	1/43	<1/27	<1/27
Rubus parviflorus	.	.	.	.	<1/21	2/38	25/100	15/100	<1/35
Vaccinium myrtillus	31/100	37/100	2/57	2/57	50/100	25/95	31/100	<1/55	2/55
Graminoids									
Bromopsis ciliata	<1/53	<1/53	<1/79	<1/29	<1/55	<1/67	<1/100	<1/100	3/90
Calamagrostis canadensis	.	.	<1/14	.	<1/5	<1/5	.	.	<1/10
Carex bella	<1/20	<1/8	<1/29	.	.	.	.	.	<1/10
Carex rossii	<1/47	<1/11	<1/7	<1/64	<1/32	<1/24	<1/29	<1/9	<1/38
Festuca thurberi	<1/7	.	.	.	<1/5	.	<1/14	.	<1/7
Luzula parviflora	<1/60	<1/63	2/100	.	<1/18	.	<1/14	<1/18	<1/22
Trisetum spicatum (*T. montanum*)	<1/13	<1/18	<1/36	<1/29	<1/32	<1/71	<1/71	<1/55	<1/42

Table A2.—(continued)

Species	PIEN/VAMY/POPU HT PIEN ph. (N = 15)	PIEN/VAMY/POPU HT ABLA ph. (N = 38)	ABLA/MECI HT (N = 14)	ABLA/Moss HT (N = 14)	ABLA/VAMY HT (N = 62)	ABLA/VAMY-LIBO HT (N = 21)	ABLA/VAMY-RUPA (N = 7)	ABLA/RUPA HT (N = 11)	ABLA/EREX HT (N = 40)
Forbs									
Achillea millefolium	<1/47	<1/11	<1/21	<1/14	<1/18	<1/10	<1/14	<1/18	1/30
Actaea rubra ssp. *arguta*	.	<1/5	<1/14	<1/7	<1/8	<1/24	<1/57	<1/45	<1/25
Arnica cordifolia	1/47	3/79	4/57	<1/7	2/37	2/57	3/100	6/100	2/47
Artemisia franserioides	.	.	.	<1/21	<1/19	2/43	2/71	2/36	2/40
Bistorta vivipara	<1/27	<1/11	<1/36	.	.	.	.	.	.
Caltha leptosepala	<1/27	<1/13	3/29	.	<1/2	.	.	.	.
Cardamine cordifolia	.	.	10/93	.	.	.	.	.	.
Chamerion angustifolium	<1/47	<1/42	2/50	<1/14	<1/44	<1/48	<1/86	<1/55	<1/52
Erigeron coulteri	<1/20	<1/3	2/29	.	<1/2	.	.	<1/9	<1/10
Erigeron eximius	<1/27	2/55	<1/29	<1/43	2/60	5/62	10/100	6/91	16/97
Erigeron peregrinus	<1/20	<1/13	<1/29	<1/36	<1/19	<1/10	.	.	.
Fragaria americana	<1/7	<1/5	<1/7	.	<1/5	<1/14	<1/14	.	<1/17
Fragaria ovalis	<1/60	<1/47	<1/64	<1/79	<1/81	<1/76	<1/86	<1/55	3/77
Galium triflorum	.	.	<1/14	.	<1/2	<1/10	<1/43	<1/18	<1/17
Geranium richardsonii	<1/7	<1/47	3/79	<1/7	<1/45	<1/38	5/100	3/82	4/72
Lathyrus spp.	<1/7	<1/3	<1/21	<1/21	2/37	3/29	3/71	2/73	2/60
Ligularia amplectens	2/67	3/55	2/43	.	.	.	.	.	<1/5
Ligusticum porteri	<1/20	<1/53	2/71	<1/14	<1/29	<1/19	<1/29	2/45	<1/40
Mertensia ciliata	<1/53	<1/45	13/100	.	<1/15	<1/19	<1/43	<1/73	2/40
Mitella pentra	.	<1/13	1/50	.	<1/2	<1/5	.	<1/9	<1/20
Oreochrysum parryi	<1/47	<1/55	1/57	<1/29	2/61	3/81	7/100	9/91	6/75
Osmorhiza depauperata	<1/20	<1/66	2/86	<1/14	<1/47	<1/38	<1/100	<1/82	<1/75
Oxypolis fendleri	<1/20	<1/5	18/93	.	.	.	.	.	.
Pedicularis racemosa	<1/20	2/79	<1/57	<1/7	<1/55	<1/10	<1/29	<1/27	<1/17
Polemonium pulcherrimum	6/100	3/97	2/79	.	<1/6	<1/19	.	.	<1/10
Pseudocymopteris montanus	<1/60	<1/63	<1/50	<1/50	<1/47	<1/48	<1/14	<1/45	<1/57
Saxifraga bronchialis	<1/20	<1/5	.	<1/21	<1/6	<1/5	<1/14	.	<1/2
Saxifraga odontoloma	.	.	5/57	.	.	.	.	.	.
Senecio atratus	.	.	.	<1/7	.	.	.	.	.
Senecio triangularis	<1/7	.	6/79	.	.	.	.	.	<1/2
Smilacina racemosa	.	<1/5	<1/29	.	<1/19	<1/38	<1/100	1/91	<1/42
Smilacina stellata	.	.	2/14	.	<1/11	.	<1/57	<1/45	<1/45
Streptopus amplexifolius	.	<1/16	1/71	.	<1/6	<1/14	<1/14	<1/45	<1/27
Thalictrum fendleri	<1/7	<1/8	1/57	.	<1/21	<1/14	2/86	3/82	2/50
Trautvetteria carolinensis	.	2/5	2/7	.	<1/6	.	.	3/9	1/5
Trifolium dasyphyllum	2/13	<1/3	.	.	.	.	.	.	<1/2
Viola canadensis	<1/7	<1/24	<1/50	<1/7	<1/29	<1/48	<1/86	1/100	2/72

Table A3.—Mixed-conifer series.

Species	PIPU/LIBO HT (N = 8)	PIPU/EREX HT (N = 13)	PIPU/CAFO HT (N = 5)	PIPU/ARUV HT (N = 4)	PIPU/FEAR HT (N = 9)	ABCO/VAMY HT (N = 13)	ABCO/EREX HT (N = 18)
Trees							
Abies concolor							
Yng regen	10/63	7/62	2/60	5/75	2/22	52/100	17/89
Adv regen	4/63	3/62	2/40	2/50	3/11	9/100	6/89
Mature	<1/13	1/46	<1/40	.	<1/22	3/77	4/67
Abies lasiocarpa							
Yng regen	8/50	<1/15	.	<1/25	.	<1/8	.
Adv regen	1/38	<1/15	.	.	.	<1/38	<1/11
Mature	<1/13	.	.	.	.	.	.
Juniperus scopulorum							
Yng regen	.	<1/8	.	.	.	.	.
Adv regen	.		.	.	.	.	.
Mature	.	.	.	.	.	.	.
Picea engelmannii							
Yng regen	4/50	<1/15	.	.	.	<1/23	<1/11
Adv regen	2/50	<1/23	.	.	.	<1/23	<1/17
Mature	<1/25	.	.	.	.	<1/8	.
Picea pungens							
Yng regen	22/100	9/92	21/100	14/100	11/100	2/15	<1/33
Adv regen	12/100	8/100	8/100	7/100	12/100	<1/15	<1/39
Mature	4/88	3/77	7/100	3/50	3/89	<1/8	<1/22
Pinus flexilis							
Yng regen	2/63	4/62	.	2/50	<1/44	<1/15	<1/17
Adv regen	<1/13	<1/31	<1/40	<1/50	<1/11	<1/8	<1/28
Mature	<1/13	<1/8	.	.	<1/11	.	<1/6
Pinus ponderosa							
Yng regen	<1/13	.	.	11/50	1/33	<1/8	.
Adv regen	.	<1/8	4/40	2/50	5/56	<1/23	<1/17
Mature	<1/13	<1/8	2/80	2/50	1/56	1/38	<1/6
Populus tremuloides							
Yng regen	2/63	2/62	1/40	44/100	3/56	6/54	4/39
Adv regen	<1/25	2/46	<1/20	2/75	2/67	6/77	3/67
Mature	<1/13	<1/15	.	.	<1/11	<1/31	<1/22
Pseudotsuga menziesii							
Yng regen	30/100	13/85	16/80	21/100	3/89	11/92	11/89
Adv regen	7/100	7/85	3/100	14/100	1/78	6/92	8/94
Mature	5/75	5/85	1/40	3/75	<1/33	5/85	6/94
Shrubs							
Acer glabrum	<1/50	<1/31	.	.	.	7/62	1/44
Amelanchier alnifolia	<1/38	<1/15	2/20	<1/50	<1/11	2/62	<1/17
Arctostaphylos uva-ursi	<1/50	<1/23	<1/20	24/100	<1/44	6/31	<1/11
Cercocarpus montanus	.	.	.	.	.	.	.
Clematis columbiana	<1/88	<1/46	.	<1/25	<1/11	<1/38	<1/56
Holodiscus dumosus	.	<1/8	.	.	.	.	.
Jamesia americana	.	<1/15	.	.	.	<1/15	1/28
Juniperus communis	2/88	2/62	2/100	6/75	<1/78	1/62	<1/28
Linnaea borealis	24/100	<1/8	.	.	.	<1/23	.
Mahonia repens	<1/25	4/31	1/20	1/50	<1/11	4/92	<1/61
Orthilia secunda	<1/100	<1/54	<1/20	<1/25	.	<1/54	<1/39
Pachistima myrsinites	9/100	2/77	<1/20	<1/50	<1/11	6/100	1/61
Physocarpus monogynus	.	2/8	.	.	.	.	<1/11
Prunus virginiana	.	<1/8	<1/20	<1/25	<1/11	<1/15	<1/17
Quercus gambelii	<1/25	<1/15	<1/40	<1/50	<1/44	<1/8	<1/28
Ribes cereum	<1/13	<1/15	.	.	.	.	.
Ribes inerme	<1/13	<1/23	<1/40	.	<1/11	.	<1/11
Rosa spp.	2/88	1/62	1/20	2/100	<1/44	<1/77	1/72
Rubus parviflorus	5/63	<1/31	.	.	.	5/62	<1/78
Swida sericea	<1/25	<1/23	.	<1/25	.	<1/8	<1/6
Symphoricarpos oreophilus	<1/75	2/54	<1/20	<1/25	<1/22	1/62	2/56
Vaccinium myrtillus	3/63	<1/15	.	.	.	22/100	.

Table A3.—(continued)

Species	ABCO/ACGL HT (N = 22)	ABCO/Sparse HT (N = 26)	ABCO/ARUV HT (N = 7)	ABCO/FEAR HT (N = 10)	ABCO/QUGA HT (N = 13)	PIFL/ARUV HT (N = 4)	PSME/FEAR HT (N = 7)	PSME/QUGA HT FEAR ph. (N = 12)	PSME/QUGA HT QUGA ph. (N = 11)
Trees									
Abies concolor									
Yng regen	27/100	15/85	22/86	10/90	22/92	.	.	<1/25	<1/9
Adv regen	11/95	5/85	5/100	4/90	10/100	<1/25	<1/14	<1/8	.
Mature	3/68	2/54	1/57	1/60	2/46	.	.	.	.
Abies lasiocarpa									
Yng regen	<1/14	.	.	.	.	<1/25	.	.	.
Adv regen	.	.	.	.	.	.	.	.	.
Mature	.	.	.	.	.	.	.	.	.
Juniperus scopulorum									
Yng regen	.	<1/8	.	<1/10	<1/8	.	.	2/42	3/45
Adv regen	.	<1/8	.	.	.	.	.	<1/17	1/55
Mature	.	.	.	.	.	.	.	.	<1/18
Picea engelmannii									
Yng regen	<1/18	<1/8	.	.	.	2/25	.	.	.
Adv regen	<1/18	<1/12	.	.	.	6/75	.	.	.
Mature	.	.	.	.	.	<1/25	.	.	.
Picea pungens									
Yng regen	<1/5	<1/15	.	.	<1/23	.	<1/29	<1/8	.
Adv regen	<1/9	<1/12	.	.	<1/15	.	.	.	<1/9
Mature	.	<1/4	.	.	.	.	<1/14	.	.
Pinus flexilis									
Yng regen	2/41	2/46	2/43	4/40	<1/38	8/100	1/57	<1/17	<1/9
Adv regen	<1/9	1/38	1/43	2/40	<1/31	13/100	<1/14	.	<1/18
Mature	<1/14	<1/19	.	<1/20	<1/31	9/100	.	.	.
Pinus ponderosa									
Yng regen	<1/9	<1/15	4/57	3/40	<1/38	.	<1/29	3/50	1/64
Adv regen	.	2/38	7/86	3/50	2/69	<1/25	<1/43	3/83	5/82
Mature	<1/14	1/38	4/86	2/50	2/69	.	2/71	3/58	2/91
Populus tremuloides									
Yng regen	2/41	2/38	.	3/30	1/23	<1/25	7/43	.	.
Adv regen	1/27	<1/27	1/29	<1/20	1/15	<1/50	.	.	.
Mature	<1/5	.	.	.	<1/8	.	.	.	.
Pseudotsuga menziesii									
Yng regen	13/86	13/92	11/100	14/100	7/77	3/75	7/100	14/92	14/100
Adv regen	7/91	12/96	6/71	5/80	4/77	2/75	4/100	7/100	5/100
Mature	3/77	6/88	4/71	2/80	2/62	3/100	2/100	2/83	3/100
Shrubs									
Acer glabrum	14/100	<1/27	<1/14	.	<1/15	.	.	<1/8	.
Amelanchier alnifolia	5/77	<1/19	<1/14	<1/10	<1/15	.	<1/29	<1/25	4/91
Arctostaphylos uva-ursi	<1/9	<1/31	24/100	1/30	<1/8	25/100	3/71	<1/17	.
Cercocarpus montanus	.	<1/8	<1/14	.	<1/15	.	<1/29	2/58	<1/36
Clematis columbiana	2/73	<1/54	<1/29	<1/60	<1/15	.	<1/14	<1/50	<1/9
Holodiscus dumosus	<1/14	<1/19	.	<1/20	<1/8	<1/25	<1/14	<1/8	.
Jamesia americana	1/18	<1/15	<1/14	.	3/23	<1/75	.	.	.
Juniperus communis	<1/27	2/54	1/57	<1/40	<1/31	4/100	1/71	<1/17	.
Linnaea borealis	<1/9	.	.	.	.	.	.	.	.
Mahonia repens	4/77	2/58	<1/43	<1/20	1/92	.	1/43	<1/25	1/91
Orthilia secunda	<1/55	<1/23	.	.	.	.	.	.	.
Pachistima myrsinites	4/91	<1/54	3/71	<1/10	<1/46	<1/25	<1/14	<1/25	1/73
Physocarpus monogynus	4/18	2/12	.	<1/10	<1/8	.	.	<1/42	.
Prunus virginiana	<1/36	<1/19	.	.	<1/38	.	<1/29	<1/33	<1/9
Quercus gambelii	2/55	<1/31	<1/43	1/20	22/100	.	.	23/100	35/100
Ribes cereum	.	<1/12	<1/14	<1/40	<1/8	.	<1/14	<1/25	<1/9
Ribes inerme	<1/5	<1/4	.	<1/10	<1/8	.	<1/14	.	.
Rosa spp.	<1/82	<1/81	<1/57	<1/50	1/69	<1/75	<1/71	<1/42	3/73
Rubus parviflorus	1/45	<1/4	.	.	.	.	.	.	.
Swida sericea	2/18	.	.	.	.	.	.	<1/8	.
Symphoricarpos oreophilus	8/82	3/77	<1/57	<1/30	5/54	<1/25	<1/43	3/67	4/73
Vaccinium myrtillus	<1/14	<1/15	.	.	.	.	.	.	.

Table A3.—(continued)

Species	PIPU/LIBO HT (N = 8)	PIPU/EREX HT (N = 13)	PIPU/CAFO HT (N = 5)	PIPU/ARUV HT (N = 4)	PIPU/FEAR HT (N = 9)	ABCO/VAMY HT (N = 13)	ABCO/EREX HT (N = 18)
Graminoids							
Bromopsis ciliata	<1/88	<1/77	<1/80	<1/100	<1/67	<1/92	3/100
Carex foenea	14/100	3/54	48/100	.	2/44	.	<9/50
Carex geyeri	.	.	7/20	.	<1/11	.	.
Carex rossii	<1/25	<1/54	<1/20	<1/75	<1/44	<1/62	<1/61
Danthonia parryi	.	.	1/40	<1/50	5/67	.	<1/6
Elymus glaucus	<1/25	.	<1/40	.	.	.	<1/6
Festuca arizonica	<1/13	<1/31	<1/20	2/50	11/100	.	<1/6
Festuca thurberi	.	<1/15	<1/60	.	<1/22	.	<1/17
Koeleria macrantha	<1/13	<1/38	<1/20	<1/100	2/100	<1/15	<1/33
Muhlenbergia montana	.	<1/23	.	<1/75	3/67	.	.
Oryzopsis asperifolia	2/50	<1/23	<1/40	<1/50	.	<1/54	<1/17
Poa fendleriana	<1/13	<1/46	<1/60	<1/50	2/100	<1/23	<1/22
Sitanion hystrix	<1/8	<1/40	<1/25	<1/78	.	<1/8	<1/17
Trisetum spicatum	<1/88	<1/23	1/60	.	.	<1/15	<1/67
Forbs							
Achillea millefolium	<1/38	<1/23	1/100	<1/75	<1/89	1/23	<1/61
Antennaria rosea	<1/25	<1/38	1/80	<1/75	<1/100	<1/15	<1/22
Arnica cordifolia	1/25	.	<1/20	.	<1/11	1/38	<1/6
Artemisia franserioides	1/63	1/46	.	<1/25	<1/22	1/69	4/67
Artemisia ludoviciana	.	<1/8	<1/40	<1/50	<1/56	.	.
Erigeron eximius	3/100	4/77	<1/20	<1/25	.	2/69	22/83
Erigeron formosissimus	.	.	1/60	<1/50	2/56	.	.
Erigeron subtrinervis	.	<1/8	.	<1/50	<1/56	.	<1/11
Fragaria americana	2/63	2/54	4/80	2/50	<1/56	<1/15	<1/39
Fragaria ovalis	3/88	<1/69	11/100	6/100	1/89	1/62	2/89
Galium triflorum	<1/38	.	2/60	.	<1/11	<1/8	1/28
Geranium caespitosum	.	<1/8	.	<1/25	<1/44	<1/15	<1/6
Geranium richardsonii	2/38	<1/38	4/100	<1/50	.	<1/46	2/67
Lathyrus spp.	2/63	<1/54	4/100	<1/75	2/56	4/69	12/89
Ligusticum porteri	<1/13	<1/8	.	.	<1/11	<1/15	.
Oreochrysum parryi	<1/63	2/77	<1/60	.	<1/44	<1/69	4/78
Osmorhiza depauperata	<1/38	<1/31	<1/80	.	<1/11	<1/54	<1/50
Pedicularis racemosa	.	.	<1/20	.	.	.	.
Potentilla hippiana	.	<1/15	<1/80	<1/75	1/100	.	.
Pseudocymopteris montanus	<1/50	<1/23	<1/100	<1/75	<1/67	<1/54	<1/61
Smilacina racemosa	<1/88	<1/38	<1/20	<1/25	<1/11	<1/62	<1/22
Smilacina stellata	<1/25	1/54	<1/40	<1/100	<1/33	<1/38	1/39
Thalictrum fendleri	3/88	3/46	1/40	.	<1/67	<1/15	2/56
Thermopsis spp.	<1/13	.	<1/20	.	<1/33	1/38	4/17
Vicia americana	<1/13	<1/46	<1/60	<1/75	<1/67	<1/23	<1/44
Viola canadensis	<1/63	<1/23	1/100	<1/50	.	<1/46	<1/61

Table A3.—(continued)

Species	ABCO/ACGL HT (N = 22)	ABCO/Sparse HT (N = 26)	ABCO/ARUV HT (N = 7)	ABCO/FEAR HT (N = 10)	ABCO/QUGA HT (N = 13)	PIFL/ARUV HT (N = 4)	PSME/FEAR HT (N = 7)	PSME/QUGA HT	
								FEAR ph. (N = 12)	QUGA ph. (N = 11)
Graminoids									
Bromopsis ciliata	<1/95	<1/50	<1/57	<1/40	<1/77	<1/25	<1/43	<1/50	<1/45
Carex foenea	<1/14	<1/15	<1/14	<1/10	<1/23	.	.	<1/8	<1/18
Carex geyeri	2/23	.	.	.	<1/8	.	<1/14	<1/8	2/45
Carex rossii	<1/64	<1/81	<1/57	<1/90	2/85	<1/75	<1/86	<1/17	<1/36
Danthonia parryi	.	.	<1/14	1/20	.	<1/25	<1/43	4/25	.
Elymus glaucus	<1/14	<1/4	.	.	.	.	.	.	.
Festuca arizonica	<1/5	<1/19	<1/43	8/100	.	<1/25	11/100	5/100	.
Festuca thurberi	.	.	.	<1/20	.	.	.	.	.
Koeleria macrantha	<1/23	<1/65	<1/100	<1/70	<1/54	<1/75	<1/100	<1/100	<1/36
Muhlenbergia montana	.	<1/19	<1/71	2/60	<1/23	.	2/57	3/75	.
Oryzopsis asperifolia	<1/18	<1/8	.	.	<1/8	.	.	.	.
Poa fendleriana	<1/50	<1/69	<1/71	1/90	<1/77	<1/25	4/100	1/92	2/100
Sitanion hystrix	<1/9	<1/19	<1/43	<1/40	<1/31	.	<1/86	<1/83	<1/55
Trisetum spicatum	<1/41	<1/15	.	.	.	.	.	.	.
Forbs									
Achillea millefolium	<1/14	<1/23	<1/29	<1/40	2/46	.	<1/14	<1/42	<1/18
Antennaria rosea	<1/5	<1/35	<1/43	<1/30	.	<1/50	<1/86	<1/42	<1/36
Arnica cordifolia	2/27	<1/15	.	.	<1/8	.	.	.	.
Artemisia franserioides	1/55	<1/50	.	<1/20	<1/8	<1/25	<1/14	<1/8	.
Artemisia ludoviciana	.	<1/15	<1/14	<1/30	<1/31	.	<1/43	<1/67	<1/36
Erigeron eximius	2/59	<1/23	.	<1/30	<1/8	.	.	.	.
Erigeron formosissimus	.	<1/4	<1/14	<1/50	.	.	.	<1/8	<1/9
Erigeron subtrinervis	.	<1/12	<1/29	.	<1/23	.	<1/43	<1/50	<1/18
Fragaria americana	<1/50	<1/46	<1/14	<1/40	<1/23	.	<1/14	<1/42	<1/9
Fragaria ovalis	<1/50	<1/35	<1/71	<1/50	1/54	<1/25	<1/29	<1/8	<1/9
Galium triflorum	<1/14	.	.	.	.	.	<1/14	.	.
Geranium caespitosum	<1/5	<1/4	.	<1/10	<1/31	<1/50	<1/71	<1/17	<1/18
Geranium richardsonii	<1/32	<1/4	.	.	<1/8	.	.	.	.
Lathyrus spp.	3/68	<1/23	<1/14	3/50	<1/46	.	<1/29	1/42	<1/9
Ligusticum porteri	1/23	.	.	.	.	.	.	.	.
Oreochrysum parryi	<1/50	<1/42	<1/43	<1/10	<1/46	<1/50	<1/14	<1/17	.
Osmorhiza depauperata	<1/36	.	.	.	<1/15	.	.	.	.
Pedicularis racemosa	.	.	.	.	.	.	.	.	.
Potentilla hippiana	.	<1/8	.	<1/30	.	.	<1/57	<1/50	<1/9
Pseudocymopteris montanus	<1/23	<1/19	<1/29	<1/20	<1/38	.	<1/14	<1/50	.
Smilacina racemosa	<1/59	<1/19	.	.	<1/15	.	.	<1/8	<1/36
Smilacina stellata	<1/23	<1/19	<1/14	<1/20	<1/8	.	<1/43	<1/8	<1/27
Thalictrum fendleri	<1/59	<1/19	.	<1/20	<1/62	.	<1/14	1/50	<1/18
Thermopsis spp.	<1/9	.	<1/43	<1/20	.	.	<1/14	3/8	.
Vicia americana	<1/18	<1/15	<1/14	<1/30	<1/31	.	<1/29	<1/42	<1/45
Viola canadensis	<1/55	<1/4	.	.	<1/8	.	.	.	.

Table A4.— *Pinus ponderosa* series.

Species	PIPO/ARUV HT (N = 10)	PIPO/FEAR HT DAPA ph. (N = 7)	PIPO/FEAR HT FEAR ph. (N = 18)	PIPO/FEAR HT BOGR ph. (N = 8)	PIPO/QUGA HT FEAR ph. (N = 21)	PIPO/QUGA HT QUGA ph. (N = 26)	PIPO/QUGA HT PIED ph. (N = 14)	PIPO/MUMO HT (N = 9)	PIPO/BOGR HT SCSC ph. (N = 14)	PIPO/BOGR HT BOGR ph. (N = 18)	PIPO/QUUN HT (N = 9)	PIPO/ARAR HT (N = 6)	PIPO/ORHY HT (N = 1)
Trees													
Juniperus monosperma													
Yng regen	<1/10	.	.	<1/25	.	.	<1/43	1/78	4/50	2/61	1/22	.	2/100
Adv regen	.	.	.	<1/25	.	<1/4	<1/7	.	<1/21	1/33	.	.	1/100
Mature	.	.	.	.	.	.	.	.	.	.	.	.	.
Juniperus scopulorum													
Yng regen	.	<1/14	<1/11	2/63	<1/24	1/35	1/21	<1/22	1/36	4/44	1/44	17/100	.
Adv regen	.	<1/14	<1/6	<1/25	<1/10	<1/23	1/14	.	<1/21	2/22	<1/33	7/83	
Mature	.	.	.	<1/13	<1/5	<1/4	.	.	<1/7	<1/17	<1/22	<1/33	
Pinus edulis													
Yng regen	<1/10	<1/29	2/56	6/75	<1/38	1/38	10/93	2/44	3/50	8/94	7/67	18/100	.
Adv regen	.	.	<1/11	4/75	.	.	4/100	.	<1/29	4/67	2/44	7/100	
Mature	.	.	.	<1/13	.	.	<1/14	.	.	<1/11	<1/11	<1/33	.
Pinus ponderosa													
Yng regen	45/100	11/100	9/94	6/63	5/90	7/96	4/79	9/78	8/93	3/94	4/78	<1/50	1/100
Adv regen	18/100	4/71	5/94	6/88	11/95	7/88	4/93	12/100	6/93	4/89	1/56	<1/33	1/100
Mature	6/100	5/100	5/100	3/100	4/100	5/100	3/100	5/100	3/100	3/100	2/89	1/67	1/100
Pseudotsuga menziesii													
Yng regen	2/40	<1/43	<1/22	.	<1/33	<1/27	<1/14	<1/11	<1/21	<1/11	.	.	.
Adv regen	<1/30	<1/14	<1/17	<1/13	<1/14	<1/23	<1/14	.	.	<1/6	.	.	.
Mature	.	.	.	.	.	.	.	.	.	.	.	.	.
Shrubs													
Arctostaphylos uva-ursi	44/100	<1/29	<1/22	.	<1/10	<1/8	<1/7	<1/11	.	.		.	
Artemisia arbuscula	.	.	.	.	.	.	.	.	.			18/100	.
Ceanothus fendleri	<1/30	.	<1/6	<1/13	<1/24	<1/38	.	<1/33	.	.	.	.	.
Cercocarpus montanus	<1/40	<1/14	<1/56	3/63	<1/24	3/69	2/86	<1/33	<1/21	<1/17	<1/56	.	<1/100
Mahonia repens	<1/10	.	<1/6	.	<1/38	<1/42	<1/21	<1/11	<1/14	.	.	.	.
Purshia tridentata	.	.	.	.	<1/10	1/23	<1/7	.	.	.	.	.	. .
Quercus gambelii	<1/50	<1/29	<1/22	1/50	28/100	27/100	26/100	1/44	<1/21	1/67	3/44	4/33	.
Quercus undulata	<1/10	.	<1/6	.	.	<1/8	<1/14	<1/11	<1/21	<1/11	33/100	.	.
Rhus aromatica	.	.	<1/6	<1/25	<1/5	<1/8	<1/21	.	<1/36	<1/39	<1/33	.	.
Ribes cereum	<1/10	<1/57	<1/50	<1/38	<1/14	<1/4	<1/21	.	<1/21	<1/17	.	<1/67	.
Symphoricarpos oreophilus	<1/20	<1/29	<1/44	<1/25	3/57	1/35	<1/21	<1/11	.	<1/11	.	<1/83	.
Yucca glauca	.	.	<1/17	<1/38	<1/5	<1/19	<1/36	<1/11	.	<1/6	<1/11	<1/67	.
Graminoids													
Andropogon gerardi	<1/10	.	<1/11	<1/50	<1/10	<1/15	<1/21	.	1/36	1/11	<1/67	.	
Blepharoneuron tricholepis	.	<1/29	<1/33	<1/63	<1/19	<1/19	<1/43	<1/22	4/64	2/39	1/56	.	
Bouteloua curtipendula	.	.	<1/6	<1/38	<1/5	<1/23	<1/14	.	<1/29	<1/17	<1/67	.	
Bouteloua gracilis	.	.	<1/17	3/100	<1/5	<1/19	<1/57	<1/22	6/64	9/100	2/89	2/83	.
Carex spp.	<1/50	<1/29	<1/22	2/63	<1/14	<1/31	2/57	2/67	2/43	1/28	2/44	.	
Carex heliophila	<1/20	.	.	.	<1/14	<1/12	<1/14	<1/11	<1/21	1/17	1/22	4/100	
Carex rossii	<1/30	3/43	<1/67	<1/25	1/48	2/65	1/29	<1/22	<1/14	<1/44	<1/22	.	
Danthonia parryi	.	17/100	.	.	<1/19	<1/8	.	.	.	.	.	.	
Festuca arizonica	2/60	13/100	11/100	13/100	6/100	.	2/57	.	.	<1/6	<1/33	<1/50	
Koeleria macrantha	<1/90	1/100	1/89	<1/63	1/81	<1/69	<1/93	3/100	<1/64	<1/83	<1/78	<1/100	
Muhlenbergia montana	2/100	4/86	4/100	10/100	2/62	2/73	3/86	9/100	5/86	2/83	5/100	.	.
Oryzopsis hymenoides	.	<1/14	<1/11	<1/13	<1/14	<1/4	<1/7	.	.	<1/6	.	.	<1/100
Poa fendleriana	1/70	3/100	2/94	<1/63	2/95	3/96	2/100	2/89	2/100	4/89	1/78	<1/83	.
Schizachyrium scoparium	<1/20	.	<1/22	4/75	2/19	2/27	1/29	<1/44	15/100	<1/50	6/100	.	6/100
Sitanion hystrix	<1/80	2/100	<1/83	<1/100	<1/86	<1/88	<1/93	2/100	1/86	<1/100	<1/89	<1/100	<1/100
Forbs													
Achillea millefolium	<1/30	2/57	<1/33	.	<1/57	<1/35	<1/7	<1/11	<1/7	<1/11	.	.	.
Antennaria rosea	<1/50	2/100	<1/67	<1/38	<1/76	<1/31	<1/29	<1/67	<1/43	<1/33	.	.	.
Artemisia carruthii	<1/20	<1/57	<1/44	<1/25	<1/14	<1/8	<1/21	<1/44	<1/29	<1/56	.	.	.
Artemisia ludoviciana	<1/30	<1/29	<1/50	1/75	<1/71	<1/73	<1/71	<1/33	<1/43	<1/39	1/89	<1/33	.
Erigeron flagellaris	<1/10	<1/57	<1/28	<1/75	<1/52	<1/31	<1/50	<1/56	<1/50	<1/50	<1/67	1/83	.
Erigeron formosissimus	<1/40	1/57	<1/28	.	<1/33	<1/15	<1/21	<1/56	<1/29	<1/11	.	.	.
Erigeron subtrinervis	.	<1/57	<1/33	.	<1/43	<1/12	<1/21	<1/11	<1/14	<1/6	.	.	.
Heterotheca fulcrata	<1/40	<1/29	<1/56	<1/75	<1/43	<1/50	<1/64	<1/56	2/86	<1/89	<1/78	.	<1/100
Hymenoxys acaulis	.	<1/14	<1/17	<1/25	<1/10	<1/15	<1/29	<1/44	<1/21	<1/33	<1/22		.
Hymenoxys richardsonii	.	<1/29	<1/33	<1/38	<1/14	<1/12	<1/50	<1/67	<1/7	<1/39	<1/11	.	.
Lotus wrightii	.	.	.	<1/25	<1/14	<1/23	<1/14	<1/33	2/43	1/39	.	.	.
Potentilla hippiana	<1/30	3/100	<1/78	<1/50	<1/52	<1/12	<1/14	<1/22	<1/7	.	.	.	.
Solidago spp.	<1/40	.	<1/11	<1/25	<1/19	<1/27	<1/21	<1/11	2/29	<1/6	<1/44	.	.
Vicia americana	<1/20	1/43	<1/6	.	<1/52	<1/27	<1/14	.	<1/14	<1/11		.	.

Table A5.—Scree forest habitat types.

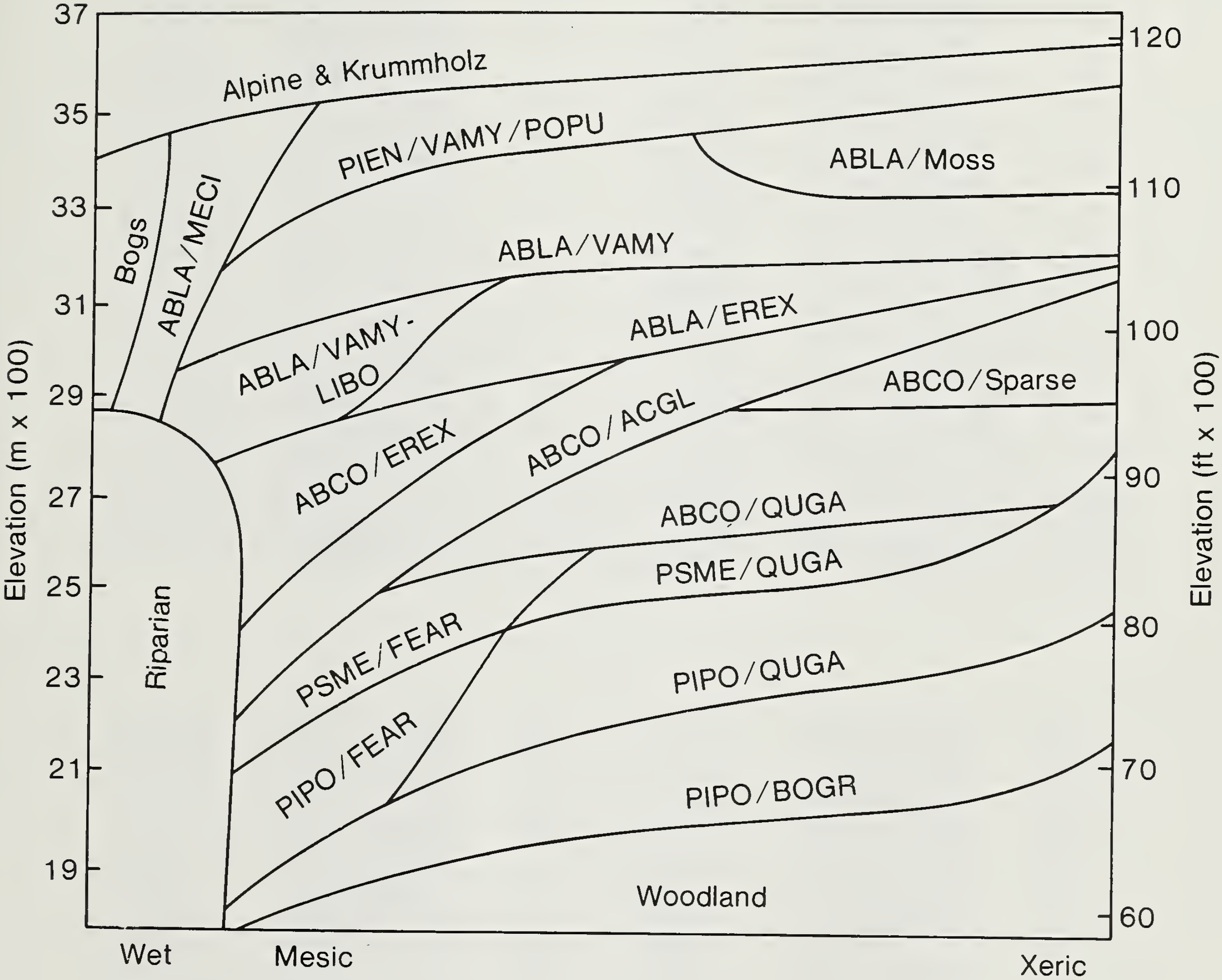
Species	PIAR/RIMO HT (N = 1)	PIEN/SABR HT (N = 8)	ABLA/SABR HT (N = 1)	ABCO/HODU HT (N = 4)	PSME/HODU HT (N = 4)	PIPO/RIIN HT (N = 1)
Trees						
Abies concolor						
Yng regen	.	.	.	2/75	<1/25	.
Adv regen	.	.	.	2/50	.	.
Mature	.	.	.	2/75	.	.
Abies lasiocarpa						
Yng regen	.	<1/13	16/100	.	<1/25	.
Adv regen	.	<1/38	20/100	.	.	.
Mature	.	<1/25	3/100	.	.	.
Juniperus scopulorum						
Yng regen	.	.	.	<1/25	<1/50	1/100
Adv regen	.	.	.	2/25	.	.
Mature	.	.	.	.	.	.
Picea engelmannii						
Yng regen	.	3/100	1/100	.	.	.
Adv regen	.	4/100	.	.	.	.
Mature	1/100	4/88	.	.	.	.
Pinus aristata						
Yng regen	3/100	.	.	<1/25	<1/50	.
Adv regen	.	.	.	<1/25	.	.
Mature	9/100	.	.	.	.	.
Pinus edulis						
Yng regen	.	.	.	1/25	.	2/100
Adv regen	.	.	.	.	.	1/100
Mature	.	.	.	.	.	.
Pinus flexilis						
Yng regen	.	<1/13	.	5/50	2/50	.
Adv regen	.	.	.	2/25	2/50	.
Mature	.	.	.	1/50	1/50	.
Pinus ponderosa						
Yng regen	.	.	.	<1/25	.	2/100
Adv regen	.	.	.	<1/50	1/50	.
Mature	.	.	.	1/50	2/50	1/100
Populus tremuloides						
Yng regen	.	9/38	.	.	.	.
Adv regen	.	3/38	.	.	.	.
Mature	.	.	.	.	.	.
Pseudotsuga menziesii						
Yng regen	.	.	.	2/75	4/100	.
Adv regen	.	.	.	<1/25	2/100	1/100
Mature	.	<1/13	.	<1/50	5/100	.
Shrubs						
Acer glabrum	.	.	.	.	<1/25	.
Cercocarpus montanus	.	.	.	<1/25	5/50	.
Holodiscus dumosus	.	.	.	4/75	3/75	.
Jamesia americana	.	<1/13	.	2/50	<1/25	.
Juniperus communis	<1/100	4/75	2/100	.	<1/50	.
Pentaphylloides floribunda	<1/100	<1/25	.	.	.	.
Quercus gambelii	.	.	.	.	.	3/100
Ribes cereum	.	.	.	1/50	<1/75	.
Ribes inerme	.	.	.	3/75	<1/25	1/100
Ribes montigenum	9/100	<1/50	<1/100	.	<1/25	.
Ribes wolfii	.	<1/38	.	.	<1/25	.
Rosa spp.	.	<1/13	.	<1/25	<1/25	.
Salix scouleriana	.	.	.	<1/25	.	.
Symphoricarpos oreophilus	.	.	.	<1/50	<1/50	.
Graminoids						
Carex geyeri	.	<1/25	.	.	.	.
Carex rossii	.	<1/100	<1/100	<1/75	<1/100	.
Festuca arizonica	.	.	.	<1/50	<1/75	.
Festuca brachyphylla	.	<1/75	<1/100	.	<1/25	.
Festuca thurberi	<1/100	<1/38	.	.	<1/25	.
Koeleria macrantha	.	<1/50	<1/100	<1/50	<1/25	.
Muhlenbergia montana	.	.	.	.	<1/75	<1/100
Poa fendleriana	<1/100	<1/38	.	3/50	<1/100	<1/100
Forbs						
Antennaria rosea	.	<1/25	.	<1/50	.	.
Artemisia franserioides	.	.	.	<1/50	.	.
Fragaria americana	.	<1/25	.	<1/50	<1/25	.
Fragaria ovalis	.	<1/25	<1/100	.	.	.
Helianthella parryi	.	.	.	.	<1/25	<1/100
Oreochrysum parryi	.	<1/13	.	.	<1/25	.
Saxifraga bronchialis	3/100	<1/63	<1/100	<1/25	<1/25	.
Sedum lanceolatum	<1/100	<1/25	.	.	.	.
Senecio atratus	<1/100	<1/50	<1/100	.	.	.
Senecio fendleri	<1/100	<1/13	.	1/25	<1/100	<1/100
Valeriana capitata	.	.	<1/100	<1/25	<1/25	.

Table A6.—Riparian forest habitat types.

Species	PIEN/HESP HT (N = 3)	PIPU/SWSE HT (N = 7)	PIPU/POPR HT (N = 6)	ABCO/GATR HT (N = 4)	PIPO/POPR HT (N = 3)
Trees					
Abies concolor					
Yng regen	6/33	35/43	5/83	36/100	.
Adv regen	13/33	5/57	4/67	14/100	.
Mature	<1/33	<1/29	1/33	3/75	.
Abies lasiocarpa					
Yng regen	5/67	.	<1/17	.	.
Adv regen	1/33	.	<1/17	.	.
Mature	1/33	.	.	.	.
Acer negundo					
Yng regen	.	.	.	.	7/67
Adv regen	.	.	.	.	9/67
Mature	.	.	.	.	2/67
Juniperus scopulorum					
Yng regen	.	1/43	<1/17	3/75	6/67
Adv regen	.	<1/14	.	2/75	3/33
Mature	.	.	.	.	.
Picea engelmannii					
Yng regen	4/100	.	<1/17	.	.
Adv regen	8/100	<1/14	<1/17	.	.
Mature	5/100	.	.	.	.
Picea pungens					
Yng regen	1/33	7/100	11/100	.	.
Adv regen	2/33	11/100	7/100	.	.
Mature	<1/33	5/100	4/67	.	.
Pinus ponderosa					
Yng regen	.	.	.	.	4/67
Adv regen	.	<1/14	.	<1/50	14/100
Mature	.	<1/14	.	1/50	3/100
Populus angustifolia					
Yng regen	8/67	11/29	.	4/75	.
Adv regen	3/100	<1/14	<1/16	1/25	<1/33
Mature	2/100	1/43	.	2/50	<1/33
Pseudotsuga menziesii					
Yng regen	3/33	4/71	2/83	12/75	<1/67
Adv regen	<1/33	3/71	1/50	2/100	.
Mature	<1/33	<1/43	.	.	.
Shrubs					
Acer glabrum	5/33	11/43	<1/17	18/100	.
Acer negundo	.	<1/29	.	<1/25	40/67
Alnus tenuifolia	24/67	14/86	2/33	11/100	.
Clematis columbiana	.	.	<1/33	<1/50	.
Clematis ligusticifolia	.	<1/14	.	6/50	12/33
Jamesia americana	.	.	8/17	<1/50	.
Lonicera involucrata	9/100	2/43	<1/17	.	.
Mahonia repens	<1/33	<1/43	.	<1/50	.
Pachistima myrsinites	2/33	<1/57	1/50	8/50	.
Prunus virginiana	.	<1/43	3/33	3/100	<1/33
Quercus gambelii	<1/33	<1/43	<1/33	35/100	24/100
Ribes inerme	.	3/43	1/50	3/75	<1/33
Ribes montigenum	4/67	<1/29	.	.	.
Rosa spp.	<1/100	2/86	6/67	<1/75	.
Rubus parviflorus	<1/33	1/29	<1/17	.	.
Salix spp.	<1/33	12/57	3/17	4/25	.
Swida sericea	6/67	6/100	.	<1/50	.
Symphoricarpos oreophilus	<1/67	1/86	2/33	<1/50	.
Graminoids					
Agrostis gigantea	<1/67	<1/14	.	2/25	.
Bromopsis ciliata	2/100	<1/86	2/67	2/100	<1/67
Calamagrostis canadensis	<1/33	7/43	.	.	.
Carex foenea	<1/33	1/29	5/50	1/25	.
Glyceria striata	.	<1/14	<1/17	<1/25	.
Poa fendleriana	.	.	.	<1/25	6/100
Poa pratensis	<1/33	2/86	22/100	11/100	38/100
Forbs					
Achillea millefolium	<1/67	2/100	2/100	<1/50	<1/33
Cardamine cordifolia	<1/33	<1/43	<1/33	.	<1/33
Disporum trachycarpum	<1/33	<1/29	.	.	.
Equisetum arvense	<1/33	<1/43	<1/17	2/75	<1/33
Erigeron eximius	2/100	2/14	8/50	.	.
Fragaria americana	5/33	3/43	4/67	<1/75	<1/33
Fragaria ovalis	<1/67	1/86	1/83	.	<1/33
Galium triflorum	<1/100	3/71	2/33	4/100	8/67
Geranium caespitosum	.	.	1/33	<1/25	1/67
Geranium richardsonii	5/100	6/100	2/67	<1/75	.
Heracleum sphondylium	4/100	2/57	<1/17	<1/75	.
Hippochaete hyemalis	.	<1/29	.	1/25	1/33
Mertensia ciliata	3/100	<1/43	1/33	.	.
Oreochrysum parryi	<1/67	.	<1/33	.	.
Osmorhiza depauperata	3/100	2/86	<1/33	<1/50	.
Pyrola asarifolia	<1/67	<1/29	.	.	.
Rudbeckia laciniata	.	1/57	1/33	1/100	<1/33
Smilacina racemosa	<1/100	<1/29	.	<1/50	.
Smilacina stellata	1/100	5/71	1/67	5/75	.
Taraxacum officinale	<1/67	2/86	1/83	<1/50	<1/67
Thalictrum fendleri	7/100	<1/57	1/50	9/100	2/33
Viola canadensis	4/100	2/57	<1/67	<1/75	<1/67
Viola nephrophylla	.	<1/29	<1/17	<1/25	.

APPENDIX 5

Mosaic Diagram of Selected Major Habitat Types of Northern New Mexico and Southern Colorado



DeVelice, Robert L., John A. Ludwig, William H. Moir, and Frank Ronco, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. USDA Forest Service General Technical Report RM–131, 59 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

Forest habitat types in the mountains of northern New Mexico and southern Colorado were identified and described to develop an ecosystem classification. The final vegetation classification is based on 618 sample plots. A total of 8 climax series, 44 habitat types, and 12 phases of habitat types are defined. Keys and descriptions for each habitat type are provided. Soils and vegetation relationships, successional trends, management implications, tree productivity from site index, and relationships to other habitat type investigations in the Rocky Mountains are discussed.

Keywords: Forest vegetation, New Mexico, Colorado, habitat types, plant communities, plant associations, forest ecology, forest management

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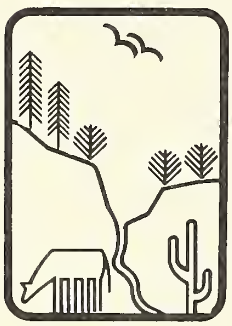
Rocky Mountains



Southwest

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